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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK .... 445, 451, 453—465

TECHNICAL ARTICLES:

Submerged Gas Pipe at Grand Forks, S. Dak. (*illustrated*). 446
A Monolithic Beton Concrete Floor (*illustrated*)..... 447
A New Process for the Computation of Logarithms..... 447
World's Columbian Exposition; Mines and Mining Department (*illustrated with inset*)..... 448
Aluminum; Its Manufacture and Uses from an Engineering Standpoint..... 450
Cast Steel Stern Frame for U. S. Cruiser No. 11 (*illustrated*) 451
Rack Tests to Determine Standard Requirement for Train Brakes..... 452
The Engineering Schools of the United States, VIII..... 459
Illuminated Semaphore Arm (*illustrated*)..... 461
The Boston Street Department..... 461
An Aeroplane Diagram (*illustrated*)..... 463
Terminal Station for the Chicago Elevated Terminal Railway (*illustrated*)..... 462
Asphalt Pavements in New York..... 463
The Kalamazoo Steel Surface Cattleguard (*illustrated*)..... 464
Traction Engines for Logging and Plowing..... 464
A Locomotive for Testing Purposes..... 464
New York State Canals..... 465

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS.....453—455

EDITORIAL NOTES 456

Locomotive Mileage—Railway Accidents due to Previous Accidents—Political Economy for Students of Engineering.

EDITORIALS:

Standard Brake and Coupler Requirements..... 456
The Great Lakes and Hudson River Ship Canal..... 457

LETTERS TO THE EDITOR..... ..... 458, 459

Cement Joints for Water Mains—Specifications for Depth of Pipes—The Kaw River Bridge, Kansas City—Effects of Dams on River Channels—An End Adjusting Gear for Drawbridges (*illustrated*)—Z-Bars and Phœnix Columns (*illustrated*).

CONSTRUCTION NEWS..... .... 465—468

Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

The break in the main conduit of the Brooklyn water-works which occurred Nov. 21, 1891 (see Eng. News, Nov. 28, p. 513 and Dec. 5, p. 540), was reported upon April 25 by Messrs. W. E. Worthen, C. C. Martin and A. Fteley, experts for the city. Their report was delayed by the impracticability of emptying the conduit for examination until Feb. 26, and by the sickness of Mr. Worthen since that time. The report is quite detailed, but does not fix the responsibility for the accident upon anyone. In substance, the report states that the conduit was probably weakened at the place of the break by the traffic on the street crossing above and that the heavy load of earth thrown upon the bank above the conduit from the trench for the new 4-ft. cast iron main probably caused the arch to be overloaded and to fail. The fact that of 70,000 ft. of the work 69,000 had been successfully accomplished, probably led to over confidence, the report states, and a neglect of extra caution at this point where the cut was deeper and the danger greater than elsewhere. At the point where the break occurred the old masonry conduit was 10 ft. wide and 8 ft. 8 ins. high. The center of the 4-ft. cast iron pipe was 13½ ft. from that of the old conduit and its bottom was 3 ft. above the bottom of the old conduit. The two conduits paralleled each other at or about at this distance for the 70,000 ft. named above. In the examination of a section of the old conduit cracks were found at or near the crown of the arch, especially at one street crossing. In general the conduit, as far as examined, was found to be in good condition, except at road crossings. The conduit has been in use since 1858.

A twin screw steamer for the New Haven Steamboat Co. was launched by the Harlan & Hollingsworth Co., Wilmington, Del., April 28. She is 315 ft. long, 48 ft. beam and 18½ ft. depth of hold.

A new cable power plant is being put in by the Chicago City Ry. at its 20th St. power house, to provide for operating the heavy traffic on the cable railway next year. Steam will be supplied by a battery of four boilers, 6 ft. diameter by 18 ft. long. The smokestack is 150 ft. high and 6½ ft. diameter. The machinery is of nearly 5,000 HP., and belt transmission is used for driving the cable wheels, this system having been found very successful with the company's present plant since 1887. The new machinery will double the power of the plant, and will be in operation by July. It will drive 20 miles of cable line. Coal handling machinery and mechanical stokers are used. The company is building a new car barn, 130x350 ft., at 91st and State Sts., at a cost of $100,000, to accommodate the 600 new cars that are being built as an addition to the present equipment of 1,500 cars. A new down town loop is being built for the exclusive use of the Cottage Grove Ave. line, the State St. cars continuing to use the present loop. At present about 115 trains an hour are turned on the loop, and the new one will double the capacity. A switch is being put in on the State St. line, by which the cars can be turned back in case of blockades. The company will probably adopt electricity for its lines on 61st and 63d Sts., and is making other preparations for handling the exposition traffic, which will undoubtedly be extremely heavy and severely test the transportation facilities.

Two dining cars have recently been built by the Chicago, Burlington & Quincy R. R., at its shops at Aurora, Ill. The cars are vestibuled, and their principal dimensions are as follows:

Length over sills	64 ft. 0 ins.
Width " "	10 " 4 "
Length over drawbars	71 " 2 "
" over roof	69 " 10½ "
Width of roof	10 " 5⅝ "
" of clearstory	6 " 5½ "
Height from rail to roof	14 " 2⅛ "
" " " floor	3 " 6⅛ "
Dining room	9 ft. 7⅛ ins. x 32 ft. 0 ins.
Seating capacity	30 passengers
Wheel base	58 ft. 0 ins.
Weight of body	56,000 lbs
" of trucks	31,000 "
" total	87,000 "

The trainshed for the Illinois Central R. R., at New Orleans, La., is to be 450 ft. in length, by 144 ft. in width. It will be built of steel arches, composed of one set of central arches 40 ft. wide, flanked on either side by arches 35 ft. wide, from which will extend on both sides cantilevers 17 ft. long, carried by steel posts bedded in cement. The trainshed will be covered corrugated iron, and will have a capacity for eight tracks. The arches are 24 ft. centers, and extend from the present building across Franklin Ave., where they have a span of 35 ft. The contract for this work has been let to the Kenwood Bridge Co., of Chicago.

The most serious railway accident of the week was a collision, May 1, on the Pennsylvania R. R., near Coatesville, Pa. An eastbound wrecked freight train had blocked both tracks, and the wreck was run into by a westbound train of mail and express cars. The engine of the latter train was derailed and overturned. The fireman was caught in the wreck and burned to death, and the engineman was seriously injured.—A similar accident occurred on the same date at Churchville, N. Y., on the New York Central R. R. A westbound freight train ran into the rear of another which was standing at the water tank, and several cars were thrown over on the eastbound track. Before flagmen could be sent out an eastbound train ran into the wrecked cars, the engineman of this train being killed. The wreck caught fire and about 25 cars were burned.

A cave-in occurred in a tunnel on the Colorado Midland Ry., near Colorado City, Colo., April 26. The fall damaged the engine and several cars of a passing freight train, and the engineman was fatally injured.

The shaft of a large flywheel in the mill of the Willimantic Linen Co., at Willimantic, Conn., broke May 1, and the wheel fell down 2 ft. into the pit, almost wrecking the engine house and badly damaging the 1,500 HP. Corliss engine, which was put in about a year ago. The wheel was smashed to pieces. It is said that the loss by damage will amount to about $40,000, but that the company had not accepted the wheel from the builders. The wheel was 28 ft. diameter, and 8 ft. 10 ins. wide. It was cast in twelve sections, each consisting of one spoke and a part of the rim. The sections were bolted together by 2½ and 2¼-in. bolts. The weight of the spokes was 36,000 lbs., and of the rim 96,000 lbs., the total weight of the wheel being 140,000 lbs. The shaft was 15 ins. diameter and weighed 54,000 lbs. It is said that the engine was developing only about 400 HP. at the time of the accident.

A serious bridge accident on the Central Vermont R. R. was noted in our issue of April 28, and we are now able to present more complete particulars. The accident occurred at Pike River bridge near Des Rivieres, Que., on April 24. The bridge is composed of two spans, one of 150 ft. and the other 125 ft., in the clear, 290 ft. over all. The railway company had commenced to erect a riveted lattice steel bridge at this point and at the time of the accident the longer span had been completed, the track over the shorter span being carried on a wooden trestle. The accident happened to a south bound cattle train about 2 a. m. The engineman discovered an obstruction on the track on the trestle about 30 ft. from the end of the steel span, and immediately applied the air brake, but the engine struck the obstruction and pushed it ahead till it reached the end of the steel span, at which point the engine was derailed and thrown against the side braces, breaking them and resulting in about 40 ft. of the floor system at that end of the bridge going down. The side of the bridge opposite where the engine struck remained intact, that portion of the span beyond the break retaining nearly its previous position, except that on the side the engine struck, and on which the braces were broken out, it settled about a foot out of surface at the end next the break, and the entire structure was carried forward about two inches in the direction the train was moving. The engine and tender went into the river, and one man was killed.

Some powerful freight engines of the twelve-wheel, or mastodon type, having eight driving wheels and a four-wheel leading truck, have been built by the Brooks Locomotive Works, Dunkirk, N. Y., for the Great Northern Railway. There are 15 of these engines, and their leading dimensions and particulars are as follows:

Cylinders	20x26 ins.
Diam. of driving wheels	4 ft. 7 ins.
" " truck wheels	2 " 6 "
" " boiler barrel	5 " 8 "
Working boiler pressure	180 lbs.
Firebox, form	Belpaire
" size at grate	9 ft. 6 ins. x 2 ft. 8 ins.
Tubes, number	250
" diam. outside	2⅛ ins.
" length	13 ft. 10 ins.
Heating surface, tubes	2,024 sq. ft.
" " firebox	120 " "
" " total	2,244 " "
Grate area	24.7 " "
Wheel base, rigid	9 ft. 8 ins.
" driving	15 " 6 "
" truck	5 " 10 "
" total engine	25 " 2½ "
" engine and tender	52 " 0½ "
Weight on driving wheels	136,000 lbs.
" on truck	30,000 "
" of engine, total	156,000 "
" of engine and tender	250,000 "
Capacity of tank	4,000 galls.
" coal space	10 tons.
Brake fittings	New York air brake

The inquiry into the cause of the failure of an uncompleted building in Chicago last month, by which six persons were killed and several injured, has led to a verdict by the coroner's jury of criminal carelessness on the part of the Commissioner of Buildings, two inspectors of the Building Department and the owner and architect of the building. The latter is said to have been a contractor only. The case will be presented to the grand jury. The building collapsed during a high wind, and it was at first thought that the wind was the sole cause of the distaster, but the inquiry proved that the building was not properly built and that the inspection was a mere farce. The coroner's jury recommended that architects should be required to take out licenses after proving their qualifications.

Street cleaning in Boston during the past year has been greatly systematized and the service improved, according to the recent report of Street Commissioner H. H. Carter, Boston. One of the principal improvements has been the introduction of a push cart patrol which has proved very effective.

The submarine boat noted in our issue of April 16, is said to have been successfully tested in the Rouge River, at Detroit, April 29. The boat is cigar-shaped, built of oak, 40 ft. long, 14 ft. high, 9 ft. wide amidships, 7 ins. thick. Mr. Geo. C. Barker is the inventor. The river was 16 ft. deep at the point the test was made, and the boat was submerged 2 ft. The motive power, when submerged, is a storage battery, which also supplies the light. A steam engine is the motive power at the surface, and drives the dynamo which charges the storage battery, which has 200 cells. The course of the boat is directed by a pilot, who stands in a small conning tower, provided with lookout holes. It is necessary in taking bearings to rise to the surface, but in so doing only the top of the tower appears above the surface. With the conning tower hermetically sealed, the interior of the boat contains 1,500 cu. ft. of air. The wheels are on each side, midway between the bow and stern, 1 ft. below the center line. The boat is raised and lowered by letting water into the hold and by deflecting the side wheels. An ordinary screw propels the boat, which has a displacement of 75 tons. It is said that the boat can run for four hours under water at a speed of 10 knots. A torpedo, also invented by Mr. Barker is fired out from a bow tube, but other kinds of torpedoes can be used.

Refrigerating plants are to be established at Kansas City, Mo., and franchises have been granted to the Ammonia Refrigerating Co, and the Cold Air Refrigerating Co. The companies propose to lay cold air conduits for cooling and refrigerating purposes, and are required to supply cold air for the public buildings and fountains.

An electric railway is to be established at Bangkok, Siam. The existing horse car line is 6 miles long, 30 ins. gage and laid with 45-lb. rails. The contract for electrical equipment, including an engine, two 65-HP. generators and six cars with a 20-HP. motor to each car, has been awarded to the Short Electric Ry. Co., of Cleveland, O.

SUBMERGED GAS PIPE AT GRAND FORKS, S. DAK.

During the summer or fall of 1891 an 8-in. submerged gas pipe was laid across the Red River for the Grand Forks (N. Dak.) Gas & Electric Co. The work was done under the direction of City Engineer W. S. Russell, to whom we are indebted for the information given below.

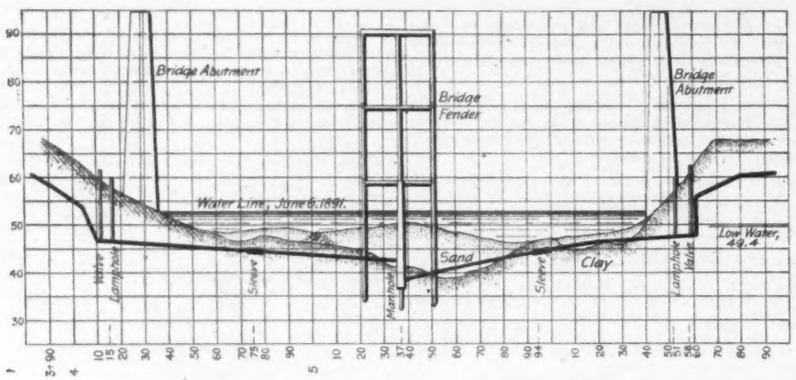


FIG. 1. PROFILE OF GAS PIPE LINE UNDER RIVER.

The river bank has a very troublesome way of sliding at Grand Forks, there being a break in the ground about 250 ft. back from the river which extends to quite a depth below the river bed. The gas pipe was laid very near to the bridge, the piers of which are shown in the profile, Fig. 1. Although the piling for the foundation of the left pier was driven 32 ft., the pier moves at intervals bodily into the river, maintaining its equilibrium. Since the erection of the superstructure of the bridge in 1888 it has been necessary to cut out 2 ft. altogether from the end of the approach on the west side of river to relieve the draw span, about 8 ins. being the most cut off at any one time. The Great Northern R. R. bridge, rebuilt in 1884, located two blocks above the gas pipe line, had been cut about 5 ft. in all up to Dec. 1, 1891.

The intake pipe for the city water works, about one-half mile above the gas pipe line, is laid in a tunnel from the river to the pumping station, a distance of about 450 ft. In 1886 it was pulled apart 18 ins. at one move, shutting off the water supply from that source. To avoid this difficulty since that time the city engineer has sleeved all pipes wherever these breaks in the ground have been found, and since sleeving they have given no trouble.

With the foregoing explanation the necessity of providing sleeves and stuffing boxes is evident.

Fig. 1 shows the river bed, the pipe line, with its manhole and sleeves, and the bridge piers, one of which has been mentioned. Fig. 2 shows the manhole, in section, with pipe connections and stuffing boxes, and the 2-in. vertical pipe extending to the top of the manhole and provided with a brass sand pump for removing the condensed gas. Fig. 3 shows the elevation of stuffing boxes on the submerged pipe, and Figs. 5 and 4 the horizontal and vertical sections through the same. The stuffing box at the top of the manhole seems to be similarly designed. Fig. 6 is a section through one of the sleeves. A gland like that shown in Fig 4½ goes with the sleeve and is secured to the flange at the left end. At the fixed end of the sleeves there are deep lead joints, well calked.

The stuffing boxes, through which the pipe is supposed to draw in case of the bank sliding, are packed with hemp and a good quality of hard oil. The sleeves placed in the river are to permit the pipe to contract; the stuffing boxes in the manhole may answer the same purpose, in case the slide should extend so far into the river.

The manhole is of ¼-in. steel, with single riveted joints, ½-in. rivets, 1½ ins., c. to c., 1½ ins. lap, chipped and calked. The steps on the inside of the manhole are ¼x1½ ins., bent to set 1½ ins. from the shell at the bottom, and fastened with ½-in. rivets. The manhole is covered with a ⅜-in. plate fastened to a 4x4x⅜-in., angle, the latter evidently being riveted to the shell, but the top plate being fastened to the angle by ⅝-in. cap screws, 3 ins. c. to c.

Each of the stuffing boxes is fastened together by four ¾-in. stud bolts, 13 ins. long, provided with check nuts. The bolts are bent to suit the angles (see Fig. 2).

For use in connection with trench excavation and pipe-laying, trestle work was built from the shore to the fender for the pivot pier of the drawbridge, the fender being an open timber structure. The lower or down river side of the trestle was placed about 2 ft. above the center line for the pipe and about 2 ft. above the water, and was built as shown by Fig. 7.

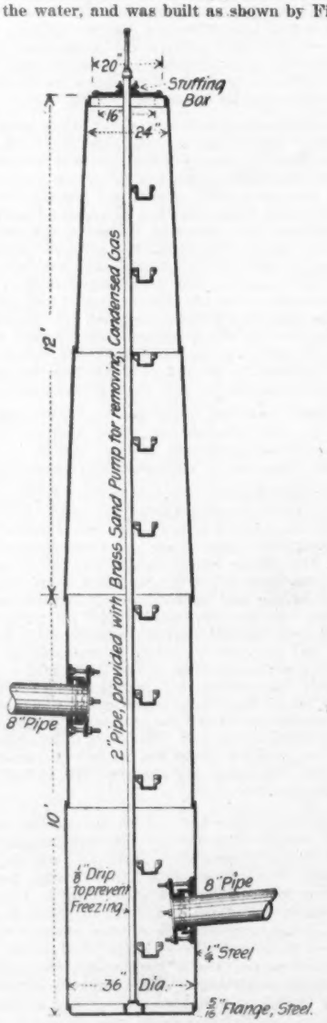


Fig. 2. Section of Manhole.

The trench was excavated with a dipper made of steel boiler plate. It had a hinged door for a bottom, and a stem or handle of the required length for holding it in position. The dipper was operated by an ordinary 10-HP. double drum hoisting engine, set in the bank in line with the trench. One rope was run from a drum to the front of the dipper to draw it ahead in loading; a second rope from one of the winches on the side of the engine, through a snatch block on the bridge fender, to the back of the dipper, to draw the dipper back to place for reloading; and a third line from the other drum to a small crane derrick set a little to one side of the trench, and from there to the bale on the dipper, to hoist the dipper and swing it onto the dump.

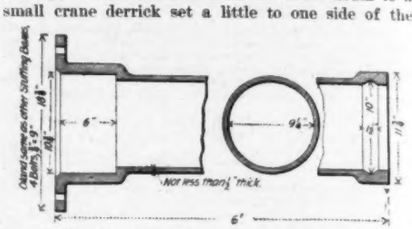


Fig. 6. Section through Sleeve.

The sand running into the trench caused some trouble, and sheet piling was found necessary on the upper side of the trench part of the way, where the cut was the deepest. The excavation for the manhole was made first and the manhole floated out and put in place, then the trench cut from the manhole to the shore on one side, the hangers placed on the trestle work, the pipe put together suspended from the hangers by the rods already mentioned. The pipe is of cast iron, 8 ins. in diameter, with flanged ends, and the joints packed with clear white pine gaskets ½-in. thick. The object in using the pine gaskets was that they permit considerable deflection without causing any leaks. This method of making joints in submerged pipes, Mr. Russell states, has been tried a number of times with larger pipes and has always proved a success.

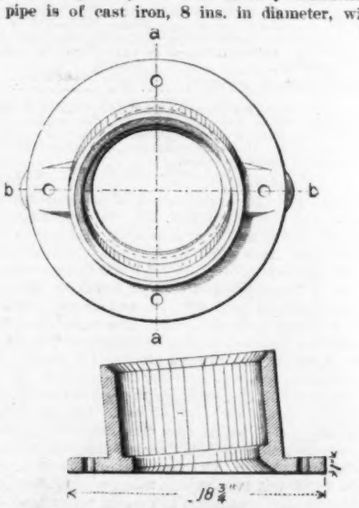


Fig. 3. Elevation of Stuffing Box.
Fig. 4. Vertical Section (a a) of Stuffing Box.

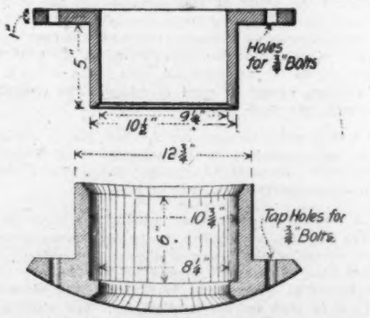


Fig. 4½. Section of Gland.
Fig. 5. Horizontal Section (b b) of Stuffing Box.

About 120 ft. of the pipe was first put together,

including the valve on the shore end. In the end next the manhole was driven a pine plug to save pumping water from the manhole when packing the stuffing boxes.

The end of the pipe next the manhole was lowered first so that it could be moved endwise into the stuffing box in the manhole without dragging on the bottom. When the pipe was properly placed the water was pumped out of the manhole, the blind heads taken off the stuffing boxes in the manhole,

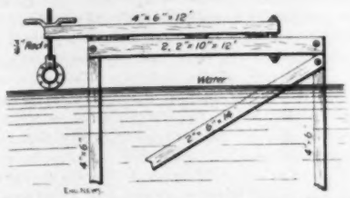


Fig. 7. Section of Trestle for Lowering Pipe.

the stuffing boxes packed and the glands bolted in place. The pipes being a close fit in the stuffing boxes much trouble from water was not experienced.

The placing of this manhole in the center of the river saved excavating to the excessive depth which would have been necessary had the pipe been laid on a continuous grade, also afforded means of making a connection in the center, as the bridge fender prevented laying the pipe in one piece; also affords an opportunity for inspection if there should ever be any difficulty, and a receptacle for the condensed gas.

In putting the pipe together a small boat was used, the pipe being lowered onto the boat with the engine and derrick, the boat floated to place and easily trimmed to the proper height for making the joints. The work was done without the assistance of a diver, and Mr. Russell states that it is absolutely tight.

A MONOLITHIC BETON-CONCRETE FLOOR.

We illustrate herewith a recently invented fireproof floor which is claimed to be superior in many respects to the ordinary construction using bricks or tile arches. We have heretofore illustrated (Eng. News, April 19, 1890) a floor in which the space between the beams is filled with solid concrete, and which has been used for some important buildings in Philadelphia. The concrete floor shown in the drawing is also a monolithic construction, but the material is so arranged that the same amount will sustain a much larger load, by constructing the floor with hollow tubular spaces, running parallel with the beams. In the ordinary fireproof floors with brick or tile arches the whole load is carried by the beams. In floors of monolithic construction the concrete between the beams sustains a large part of the transverse stress, and lighter beams can be used than with brick or tile arches.

In constructing the floor herewith illustrated a temporary floor is suspended from the beams to support the concrete while setting, and a very rich concrete is laid upon it to a depth of several inches. The tubes are made of rich concrete, and vary in size according to the span of the beams and their

Section of Floor.

spacing and the total depth of the floor. The tubes are made in short lengths and in halves, and in laying them the joints are well cemented and the outside is flushed all over with grout. They are so laid that the upper and lower halves break joints with each other. The space at the sides of and above the tubes is filled with concrete of a cheaper grade than that used for the lower layer and for the tubes. The top of the floor may be of wood, asphalt, tiling, or of the concrete itself, as desired. When the concrete has set, the temporary floor supporting it is removed, and the ceiling is covered with whitewash, plaster, tiling or other finish.

The inside dimensions of the tubes vary according to the inventor's designs from 12½ and 9 ins. for floors of 20 to 30 ft. span, with 8-in. beams spaced 5 ft. 9 ins. apart, to 7 and 4½ ins. for floors of 14 to 18 ft. span, with 5-in. beams spaced 3 ft. 6 ins. apart. The safe loads per square foot of floor vary from 130 to 570 lbs., in sample designs submitted to us, and any desired load can be arranged for as readily as with the ordinary construction.

It will be noted that the tubes are placed near the upper surface of the concrete. This is because the compressive strength of concrete is several times as great as its tensile strength. The inventor assumes the ratio as 8 to 1. Computing the strength of the construction, he finds that a floor of 20-ft. span, with 7-in I-beams weighing 15½ lbs. per ft., and spaced 4 ft. apart, c. to c., will sustain a load of 200 lbs. per sq. ft. with a factor of safety of 4. The total depth of the concrete would be 9½ ins., and four tubes would be used with cross-section 5½x8¼ ins. in dimensions. The cost of such a floor is estimated as follows:

7-in. I-beams, 15½ lbs., per lin. ft., per sq. ft. floor = 4 lbs., at 3 cts. per lb.	12 cts.
Concrete, tubes, etc., made and laid, (at $10.80 per cu. yd. of floor, including volume of tubes).	30 cts.
Total cost per sq. ft. of floor.	42 cts.

By the ordinary method of construction a floor of similar strength would cost:

12-in. I-beams, 32 lbs. per lin. ft., per sq. ft. floor = 8 lbs., at 2.75 cts. per lb.	22 cts.
Hollow brick or tile arch, per sq. ft. floor.	34 cts.
Total cost per sq. ft. of floor.	56 cts.

Thus the apparent saving over the ordinary method of construction is about 25 per cent. Further information concerning this method of construction may be obtained from its inventor, Mr. C. F. Terney, 59 East 106th St., New York City.

A NEW PROCESS FOR THE COMPUTATION OF LOGARITHMS.

Not many of our readers can have a strictly professional interest in the computation of logarithms, as the chances to follow that profession as a means of livelihood are now limited, all the logarithms for which there is much need having been long since computed. Nevertheless, a great many of our readers are interested in mathematical curiosities and novelties, and we think they will find that the paper subjoined, which we received lately from Mr. Geo. W. McCready, City Engineer of Moncton, N. B., fairly comes under that head. Not trusting to our own judgment in this matter, we forwarded the manuscript to Prof. Mansfield Merriman, of Lehigh University, as well qualified to judge of it as any one in the country, and received from him the following response:

I return inclosed Mr. McCready's MS. on logarithms, which has been very interesting to me. It is a simple and curious method which should rank high as a mathematical curiosity. I have not seen it elsewhere, and it is probably new.

Nearly twenty years ago I wrote a treatise on logarithms giving the complete theory, the history, methods of computation, comparison of precision of tables, and also a set of 5-place tables. I still have the MS. (an "unpublished gem"), and on referring to it I find a table giving certain constants and logarithms to one hundred decimals, with which Mr. McCready's values for log 2 and M agree as far as they go.—Yours truly,

Mansfield Merriman.

As there rarely proves to be anything new under the sun when sufficiently extended inquiry is made, we are prepared to learn that Mr. McCready's method of computation is not really new, but our mathematical readers will read it with interest:

As the logarithms of numbers are the exponents of the different powers to which a constant number must be raised in order to be equal to those numbers—that constant number being the base of the system, and as common logarithms have 10 for their base, it follows that

$$10^{.30103} = 2\ ;\ 10^{.47712125} = 3\ ;\ 10^{.845098} = 7.$$

etc., the exponents here given being respectively the logarithms of 2, 3 and 7. But from the nature of decimals,

$$.845098 = \frac{845098}{1000000}$$

Consequently $10^{\frac{845098}{1000000}} = 7$, and $7^{\frac{1000000}{845098}} = 10$.

Hence the rule:

Involve to the 10th power the number of which the logarithm is required and the power of 10 which it contains will be the first figure of the logarithm; again involve to the 10th power, and the powers of 10 contained in it will be the second figure, etc.

This process requires only multiplication; as the number of places that the decimal point can be removed to the left in each case, without reducing the number to unity, shows what power of 10 is contained. If the number contains more than one integer, the separatrix is first to be removed to the left of all but the left hand figure, and the number of figures passed over will be the characteristic of the logarithm. The calculation is to determine the mantissa.

2. What is the logarithm of 20? This contains one power of 10, giving 1 for the characteristic. We have then 2.0 to be involved to the 10th power, which is 1024. Here the decimal point can be moved three places to the left; hence 3 is the first figure of the mantissa. Again

$$1.024^{10} = 1.2676506002282294.$$

and as this does not contain a power of 10, the second figure of the mantissa is 0. By continuing the involutions to the 10th power, we get successively:

1.07050860718626 7
1.99506311688073
9.99002093014 25
9.90065629.282
9.04981730624
3.68466593 65
4.61297.5995
4.36326855
2.5010321
9.576188
6.48525 ! ! ! !.
1.31601 ! ! ! !.
1.558
8.44
1.8 ! ! ! ! ! ! ! ! ! ! etc.

showing the logarithm to be 1.30102999566398119, being correct to 17 places of decimals. Whatever degree of accuracy may be considered requisite in any case, it will generally be found necessary to use in the calculation as many places of decimals as are required in the logarithm; except that, as the work progresses, the number of figures may be gradually reduced, without detriment to the result, as it is daily necessary to have the powers of 10 correctly.

The peculiarity of the system is, that the logarithm of any number can be computed directly from the number itself, and hence the operation can be performed by a child.

So much for the first principle of the system. At the same time there is an evident disadvantage in involving to the 10th power, which requires four multiplications, and the 16th power would require no more. And as the same result may be obtained by a series of squares, cubes or other powers, it will be a good check on the former work to compute by successive squares the logarithm of 2.

$$2^2 = 4\ ;\ 4^2 = 16\ ;\ 1.6^2 = 2.56\ ;\ \text{and}\ 2.56^2 = 6.5536.$$

etc., carrying the computation only to 7 places of decimals, as given in Table 2, where the successive squares are tabulated, with a reduction of one decimal figure for every three involutions, and the powers of 10 placed in order beside the numbers.

Table 2.

2.	
0 = 4. = 2^2	
1 = 1.6	
0 = 2.56 = 1.6^2	
0 = 6.5536	
1 = 4.2949673	
1 = 1.8446744	
0 = 3.4028237	
1 = 1.157921	
0 = 1.340781	
0 = 1.797693	
0 = 3.23170	
1 = 1.04439	
0 = 1.09075	
0 = 1.1897	
0 = 1.4155	
0 = 2.0035	
0 = 4.014	
1 = 1.611	
0 = 2.596	
0 = 6.74	
1 = 4.54	
1 = 2.07	
0 = 4.3	
1 = 1.8.	
0 = 3.3	
1 = 1.	

Powers of 10.

Table 3.

1	0
0	5
1	25
0	625
1	3125
1	65625
0	828125
0	4140625
1	20703125
0	603515625
0	301757812
0	150878906
0	075439453
0	037719726
1	018859863
0	509429931
0	254714965
0	127357487
1	063678743
0	531839371
1	265919685
1	632959842
0	816479921
0	408239960
1	204119980
0	602059990
	301029995

Powers of 10 in inverted order.

Now, it may as well be remarked, before proceeding any further, that the powers of 10 as here given in direct order (01001101, etc.) are really the common logarithm of 2, represented in a binary system of notation, and the work which follows is necessary to reduce it to the decimal system.

For this purpose let these powers of 10 be again placed in a vertical column, beginning with the last, and then divide successively by 2 (the index of the power used and the base of the system), until the whole number has been divided, and the required logarithm will be obtained in the decimal system, as in Table 3 above.

This gives the logarithm of 2 correctly to 9 places of decimals. If it be urged that new theories in this line are now of no practical value, since the labor of com-

puting the necessary tables has already been performed, it may be well to remember what sometimes happens, that a logarithm is required to several places of decimals beyond what is given in any accessible table. Here the same process will apply by involving the number about ten times for an extension of three figures. Thus the tenth number in the foregoing series of squares is 1.797696, the logarithm of which is .2547155. Let this be placed to the right of a vertical line, and the powers of 10, in inverted order, to the left, and perform the requisite number of divisions by 2, as before, and we shall have the required logarithm correctly to 10 places of decimals as shown by Table 4.

In all the above involutions the contracted system of multiplication has been used.

To compute the natural number corresponding to a given logarithm, let two numbers be placed at the head of two vertical columns, the numbers taken at random, but as nearly as may be guessed in the ratio of a natural number to its logarithm, as in Table 5, and if the half of the number in the first column be taken, and the

Table 4.

0	2547155
0	12735775
1	063678875
0	5318394375
1	26591971875
1	63295985937
0	81647992968
0	40823996484
1	20411998242
0	60205999121
	.30102999560

Table 5.

Log.	Nat. No.
.15	1.6 assumed.
.075	1.26491
.0375	1.12467
1.01875	1.06050
1.50937	3.25654
1.75468	5.70661
1.87734	7.55421
1.93867	8.69149
1.96933	9.32279
1.98466	9.65546
1.99233	9.82622
0.99616	9.91273
1.49808	3.14845
1.74904	5.61110
.87452	7.49069

square root of the second, for any number of times in succession, the ratio between the corresponding members of the two columns will remain constant. But let a unit be for a few times prefixed to the numbers in the first column, and the decimal point in the second moved one place to the right, before extracting the root, and the ratio of the two columns will rapidly approach the true logarithmic series. The occasional omission of the prefixed unit in the first column and of the corresponding decimal point in the other, will keep the numbers from running into the higher digits. Here we find the number having for its logarithm .87452 to be 7.49069, which is true to the fifth place of decimals, although .15 is far from being the logarithm of 1.6.

But in this we have simply in principle the reversal of the process at first given for computing the logarithm of any number. Let it then be required to ascertain the natural number corresponding to .69897, as in Table 6.

Table 6.

0	.69897	= 4.9999995
1	.39794	= 2.4999996
0	.79588	= 6.249998
1	59176	= 3.906247
1	18352	= 1.525877
0	36704	= 2.32830
0	73408	= 5.42100
1	46816	= 2.93872
0	93632	= 8.63606
1	87264	= 7.45815
1	74528	= 5.5624
1	49056	= 3.0940
0	98112	= 9.5731
1	96224	= 9.1645
1	92448	= 8.3988
1	84896	= 7.054
1	69792	= 4.976
1	39584	= 2.476
0	79168	= 6.132
1	58336	= 3.760
1	16672	= 1.414
0	33344	= 2.0

Here the number is multiplied by 2, and the product again multiplied as often as may be deemed necessary, observing that any increase of the number of digits is to be prevented by cutting off the left hand figure when required. The second column is computed from the bottom upwards, by successive extractions of the square root; the decimal point being removed one figure to the right at each unit cut off in the first column, and the number of figures used being gradually increased as the work progresses. If a sufficient number of multiplications has been performed in the first column, or if the last mantissa is very small, the second column may be commenced with unity (or with 10, if 1 has been cut off), but, as in the present instance, the last mantissa is known to be a little more than the logarithm of 2 (2.15 more nearly), it is considered sufficiently near to begin the second column with 2; and as the system rapidly reduces the error, the result is given in the number at the head of the column, which is about three units astray in the seventh place of decimals, the true number being a little less than 5. Had the second column been commenced with 2.155, of which .33344 is the logarithm, the result would have been true to at least 10 places of decimals. Or, with only 10 multiplications by 2, and as many extractions of the square root, beginning the second column at the bottom with 55.6263, the natural number for 1.74528, the last root would have been a reliable extension to three or four places of decimals beyond what is given in ordinary tables of logarithms.

The log. of 2 is given below, as computed by the system hereinbefore set forth: .3010299956639811952l2, the error in which is only one unit in the 21st place of decimals.

Another method of computing logarithms is founded on the hypothesis that as any two numbers, m and n, have an arithmetical mean,

$$\frac{m+n}{2};$$

and also a geometrical mean,

$$\sqrt{m\,n};$$

so there must also be a logarithmic mean. And since modulus, divided by the true logarithmic mean of any two numbers whose difference is unity, must give the difference of their logatrithms, the essential prerequisites of the system are, first, that modulus be determined to the requisite degree of accuracy, and, second, that we have a true formula for determining the logarithmic mean. The former I have computed with great care to 24 places of figures, which are as follows:

.434294481903251827651129

But as my formulas for the latter are only approximate I will here submit only one, which may be applied where the ratio of the two numbers is not too great.

$$\text{Log. m} = \frac{\text{a m} + 2\,\text{g m}}{3} \text{ nearly};$$

a m signifying the arithmetical mean, and g m the geometrical mean.

Q. What is the logarithm of 999? As the logarithm of 1000 is known, we have

$$\frac{999+1000}{2} + 2\sqrt{999 \times 1000} = 999.4999 = 1062197394 = \text{log.}$$

$$3$$

mean nearly.

Divide modulus by this number, and we get .0004345117-7401769116, which, subtracted from 3.0 (the log. of 1000) gives 2.9995654882258230884, the error in which is less than 2 units in the 19th place of decimals.

WORLD'S COLUMBIAN EXPOSITION; MINES AND MINING DEPARTMENT.

(With inset.)

Mines and Mining Building.

The construction of the main buildings of the World's Columbian Exposition, at Chicago, will present much important work in the way of iron and steel domes, trusses, roofs, etc., which will be of considerable engineering interest. One of the most interesting of these structural works is the steel construction of the Mines and Mining Building, which we illustrate first, as it is the first of the main buildings to be completed. The details of this building are shown by the drawings on our inset sheet. This building, the general appearance of which was illustrated and described in our issue of Feb. 13, is 700 ft. long and 350 ft. wide, covering an area of 5.6 acres, and the estimate of cost was $260,000. The architect was Mr. S. S. Beman, of Chicago. The building is one of the group fronting on the central plazza, and has an entrance on each side, the main entrances, on the north and south sides, being 110 ft. high and 88 ft. wide, with openings 56 ft. high and 32 ft. wide. The main fronts are 65 ft. high to the cornice line, and at each corner is a pavilion 68 ft. square and 90 ft. high, surmounted by a low dome. Between the main entrances and the pavilions are arcades forming an open loggia on the gallery floor level. These covered promenades are each 230 ft. long and 25 ft. wide, with numerous points of access to the interior. The ground floor is divided into four main sections by broad aisles, and in the center of the building, whence the main avenues radiate, is a circular court, in which an imposing design will be erected, emblematic of the mining industry. The gallery is 60 ft. wide and 25 ft. above the main floor. It extends entirely around the building, and affords a floor space of 103,000 sq. ft. Eight broad stairways lead from the main floor to the gallery. The power provided will be concentrated at convenient points in the building for its distribution on the ground floor, where demonstrations will be undertaken. Numerous apartments have been provided for the special collections, and rooms for laboratory work, libraries, literature, pictures, photographs, drawings, charts, relief models, etc., are contemplated in different portions of the gallery, which is intended for the more scientific display of minerals, both precious and economic, precious stones, economic geology, etc. Restaurants, and toilet, reading and lounging rooms for the comfort and convenience of visitors, are provided in different parts of the building.

The central portion, which is constructed of steel, is 580 ft. long and 230 ft. wide, surrounded on all sides by a timber construction 60 ft. wide, as shown by the plan and general cross section, making the total size of the building 700x350 ft. The exterior is covered and decorated with staff work, and the roof is largely of glass. Work was commenced in July, 1891. Mr. Dion Geraldine, General Superintendent at Jackson Park, states that the building is now practically completed, with the exception of part of the exterior covering; about two-thirds of this is in place on the south and east sides and part on the north side of the building. The main entrance on the south side, on the central plaza and facing the Administration Building, is completed, and the coloring of the staff work, which is a rich cream color, is also well advanced. All the interior work, except painting, is finished, and all skylights, roofing, flag poles, windows, doors and stairs are in place. The main construction includes 1,580,500 lbs. of steel, 4,800,000 ft. B. M. of lumber, 68,450 sq. ft. of skylight, and 14,000 sq. yds. of interior plastering. The principal contracts for construction were as follows:

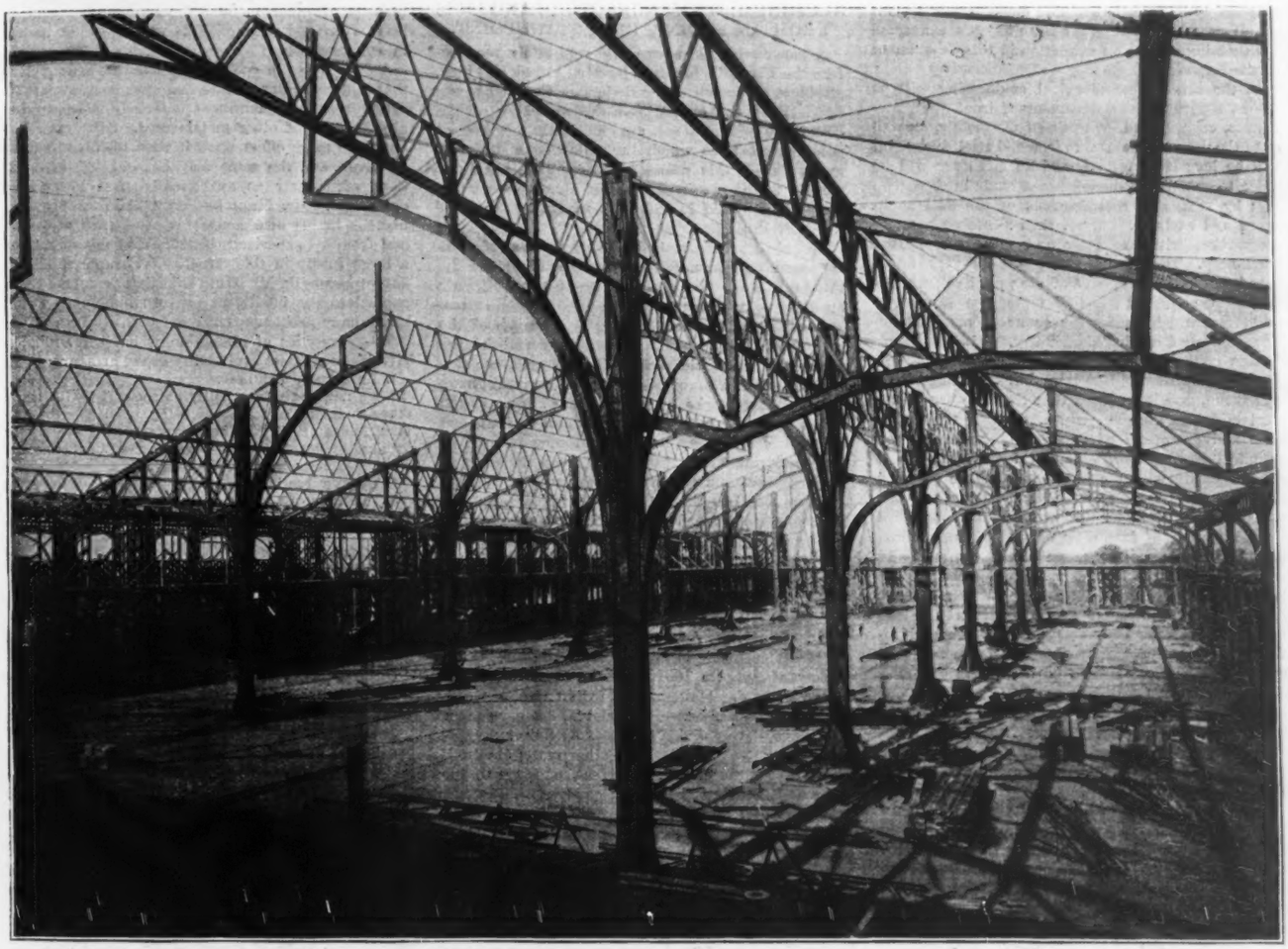
Iron work; King Bridge Co.	$57,525
Carpentry; Barnett, Record & Chapman.	112,841
Painting and glazing " " "	5,700
Lathing and plastering " " "	2,100
Installation tracks " " "	2,100
Exterior covering: Phillipson Decorative Co.	34,800
Roofing, sheet metal work and skylights; James A. Miller & Bros.	24,656
Architectural modeling; Leopold Bonet	4,835
Total	$244,557

The arrangement of the steel construction is very interesting, and is shown, together with details, upon our inset sheet. It consists in the main of steel columns carrying pin-connection steel roof trusses consisting of cantilever arms and a suspended span which forms the clearstory truss. The general design of this arrangement was made by the architect, Mr. S. S. Beman, the cantilever construction of the roof being shown on the original plans which he submitted, and he is to be credited with the design of a very bold and handsome structure. All the details of the iron work construction were worked out in the office of the Bureau of Construction under the supervision of Mr. D. H. Burnham, Chief of Construction; Mr. E. R. Graham, Assistant Chief of Construction; and Mr. E. C. Shankland, Engineer of Construction. The contract was awarded to the King Bridge Co., of Cleveland, O., and the plans were checked by that company's engineer, and followed with some slight modifications. The work was done under the specifications prepared by the Bureau of Construction, which were published in our issue of March 26. The work is of steel throughout; tensile strength, 60,000 to 68,000 lbs., with an elastic limit of half the tensile strength; elongation, 24 per cent.; reduction of area, 40 per cent. The shearing on steel rivets and pins was limited to 10,000 lbs., and the pressure on bearings of same to 20,000 lbs. per sq. in. Extreme fiber strain on pins, 25,000 lbs. per sq. in.

There are ten main trusses in the length of the building, spaced 64 ft. 5 5-16 ins. apart, c. to c. This wide spacing of columns and roof trusses necessitates the use of heavy trussed purlins, as shown on the drawings. The exterior columns are built up of plates and angles, with two latticed sides, and have a cross section of 16x12¾ ins. The main or interior columns have the four sides made up of plates and angles. Their cross section is 30¼x18 ins., and the two sides are flared out at the base to a size of 8x2 ft. for the shoe bearing. The height from base of shoe to top of cap is 63 ft. 2 ins. for the interior and 43 ft. for the exterior columns, while the total height from the floor to the top of the suspended clearstory truss at the middle is about 94 ft. The main trusses are, as already mentioned, on the cantilever principle. The width of the building is made up of a middle span of 115 ft. c. to c. of columns, and two side spans of 57 ft. 6 ins. c. to c. of columns. The middle span is formed by two cantilever arms supporting a clear story truss. The cantilevers are 92 ft. long, with anchor arms of 57 ft. 6 ins. and cantilever arms of 34 ft. 6 ins., carrying the central suspended truss of 46 ft. span which forms the clearstory. The maximum upward lift on the outer columns is estimated at 47 tons, and is provided for by a crib anchorage. There are 13

lines of purlins, as shown by the plan, which represents the arrangement for one quarter of the building. The detail drawings show the construction of purlins (A), over the side columns; purlins (B), over the main columns, and purlins (C), at the ends of the cantilever arms. The interior view of the work before completion, which is taken from a photograph sent us by the King Bridge Co., shows very clearly the arrangement and construction of the work.

The steel work was erected in October and November, 1891, and during one week there were four trusses erected, not counting the clearstory spans. Mr. Lundie, the Chicago agent for the King Bridge Co., states that the method adopted for the erection was very simple. All the exterior columns were first put in place by means of house derricks, the anchorage bolts being sufficient to hold them in position. A traveler was then constructed, consisting of two gin poles 30 ft. apart, braced together, and tied and braced at the back to a platform on which was mounted a small hoisting engine. The traveler was placed with one pole opposite the position of one of the main columns, bringing the other pole opposite the center of the end span. The main column was then raised by block and tackle from the inside pole, and the end span was raised from the outside pole. The traveler was then moved laterally a sufficient distance to allow it to pick up the cantilever arm. The repetition of this process throughout the building served for the erection of the cantilever trusses. The clearstory trusses were placed in position by the same traveler, beginning at one end and running right through. The purlins, with the exception of those in the clearstory, which were raised by the traveler, were put in place by means of house derricks.



INTERIOR VIEW OF MINES AND MINING BUILDING; WORLD'S COLUMBIAN EXPOSITION.
King Bridge Co., Builders.

Mines and Mining Exhibits.

The scope of the exhibits is expected to be very complete and comprehensive, and in addition to specimens of ores, ingots and bars of finished metals, etc., will include models of mines, mining plant and machinery, metallurgical operations, etc. Exhibits from abroad are made by the official World's Columbian Exposition boards or commissions of each country, a space in the building being reserved for them, and the nature of the exhibits being largely decided by these commissions. The participation by foreign countries is to be quite general and extensive, including all the leading mineral producing and metallurgical countries, comprising Great Britain, France, Germany, Austria, Belgium, Sweden, Norway, Greece, Mexico, India, and Canada, as well as the leading republics of Central and South America. The amounts of space for foreign countries range from 1,000 to 25,000 sq. ft., and aggregate over 75,000 sq. ft. In nearly all the mineral producing states of this country special superintendents or committees have been appointed to take charge of the work of collecting and arranging the state mining exhibits. This work is very thoroughly organized and is being pushed with vigor, with the assistance of the Department of Mines and Mining. Mr. F. J. V. Skiff is chief of this department.

While each state will expect to present as elaborate an exhibit as possible, showing its mining and metallurgical operations, such an exhibit will necessarily be somewhat local in character, and the department will, therefore, endeavor to associate and combine them so as to bring out strongly the national character of the exhibits as a whole. In furtherance of this idea a special effort has been made by the department to secure a scientific and technical collection of models of mines. Such models as are employed as evidence in mining cases are, as a rule, more exactly correct and better constructed than ordinary mine models, and also show the peculiarities of lode formation and geological irregularities which usually pass unnoticed. All of the owners of such models as have been used in mining suits have been corresponded with, and the responses have almost invariably been favorable to a loan. These models will be interesting to engineers, and will be displayed in a room set apart for that purpose.

Mining machinery will be shown largely by models on a quarter-size scale in the case of the more ponderous kinds. Where practicable, firms and individuals will be permitted to erect and operate the different varieties of mining machinery, and the department has now on file applications from numerous firms wishing to make such displays in one or more of the mining machinery groups of the classification. These exhibits will cover improved quarry machinery, such as channeling and other steam quarrying machines, compressed air and electric boring and drilling tools and machinery (including direct blow, long wall, and cutter bar machines), various types of drilling engines, boilers, casing, pipe, drilling and fishing tools, ropes, and all fittings used in artesian, gas, and oil-well drilling; diamond and steam rock drills for breaking out ores; also shaft sinking and tunneling plant. Under pumps, engines, and apparatus used in mining for pumping, draining and hoisting, will be shown steam and electric power pumps, vertical deep well pumps, rotary force pumps; also complete hoisting plants, with portable hoists, and boilers, ropes, cages, cars, etc. A great variety of elevating and conveying machin-

ery will be displayed, comprising all methods of underground haulage and surface conveyance. The ventilation and lighting of mines will also be included. The department hopes to have in operation on the exposition grounds, for demonstration, a tramway for the transportation of ores and raw materials to the Mining Building. To illustrate the preparation of ores, there will be installed improved crushers, three and five stamp mills, quartz mills, ore and stone crushers and special varieties of pulverizers. Under concentrating, separating and sizing appliances, will be shown numerous vanners, belt rolls, jigs, revolving sizers, coal screens, etc. Ore and dump cars, buckets, steam shovels, coal tips, conveying plant, etc., will be exhibited, and it may safely be said that mining machinery and plant of all descriptions and for all purposes connected with mining will be on exhibition in this department of the Exposition.

In the line of metallurgical engineering will be shown separately the treatment of iron, steel, aluminum, copper, lead, and other base metals, as well as of the precious metals. In iron and steel the exhibit will be largely historical, and an endeavor will be made to exhibit the advancement made in these two arts by means of reproductions of the first appliances and early machinery, thus affording a direct comparison with the later and more complicated machinery. The department has been very fortunate in securing an exhibit of the primitive furnaces and of the original "Kelly" (otherwise Bessemer) converter, which marks the commencement of the Bessemer steel era in this country. Of course such foreign countries as Germany, Great Britain, Belgium and Sweden will be represented extensively in this group, and it is stated that they are creating a steel and iron division, which, through the assistance and patronage of governmental officials and technical associations, promises to be on a scale commensurate with the importance of the industry in those countries. The leading aluminum reduction establishments in this country have signified their intention of installing complete plants, illustrating the electrical reduction of this commercially new metal. The electrical treatment of copper ores is to be similarly shown by a large Western copper firm. The concentration of copper ores and the methods of washing, stamping, separating and refining it as performed by the great companies of upper Michigan are also to be demonstrated. Several large Chicago and Western firms will bring out the methods and processes employed in gold, lead and silver smelting and refining furnaces and apparatus, converters, molds, cars, pots, electrolytic tanks, etc. Assaying apparatus and methods will also be exhibited.

The display of coal will be qualitative rather than quantitative. The different varieties produced by the different localities will be shown, together with their chemical analyses and the results of tests determining economic value and adaptability to various uses. The coal resources of countries, states and sections will be shown by geological maps and drawings, exhibiting the stratification, cross-section, etc., which will render apparent the extent and accessibility of the vast number of coal beds and veins which underlie the earth's surface.

The iron industry will be very extensively represented, special attention being given to the recent development of the iron resources of the Southern states. It is intended to give ample data as to the location and extent of the greater deposits, the analyses of the ores, with all the machinery and devices employed in mining, hoisting, conveying, storing, etc. Statistics, not only based upon the operations of the past, but in a degree indicating the extent to which they may be carried on in the future, will constitute a valuable feature of this division.

Every provision has been made for the installation of the ores of both the precious and base metals, and cabinets of mineral specimens contributed by private individuals, associations and technical and mining schools. There will also be specimens of asphaltic and cement mixtures, artificial stones, etc., for paving and other purposes. Salt mines and salt works will be represented. Special attention will be paid to securing historical and statistical matter, including specimens and models of ancient tools, appliances and processes.

In regard to engineers' plans and drawings, it is expected to install in a room provided for that purpose very elaborate contributions of surface and underground surveys and plottings, projections of underground work, location of shafts, tunnels, etc.; plans showing methods of sinking and lining shafts, timbering and driving tunnels, stoping, breaking down ore, etc. These will be included in the group providing for the exhibition of the history and literature of mining.

From the above notes it will be seen that a most comprehensive scope of exhibits is being provided for, and the Mines and Mining Department will, therefore, be of great interest to engineers in all branches of the profession.

ALUMINUM; ITS MANUFACTURE AND USES FROM AN ENGINEERING STANDPOINT.

A paper with the above title was lately read before the Franklin Institute by Mr. Alfred E. Hunt, president of the Pittsburg Reduction Co., and to the courtesy of the author and the secretary of the Franklin Institute we are indebted for revised proof sheets from which the following abstract is made, but in this connection we would refer our readers to the previous paper of Mr. Hunt on this subject, published in full in Engineering News of Feb. 28, 1891:

The only concerns in the United States manufacturing aluminum commercially, says Mr. Hunt, are the Pittsburg Reduction Co. and the Cowles Electric Smelting & Aluminum Co. In Great Britain there is the Metal Reduction Syndicate, a branch of the Pittsburg Reduction Co.; in Switzerland is the Aluminium Industrie Actien Gesellschaft, at Neuhausen, and in France is the firm of Bernard Bros., now building works at St. Michael's, to use the Minet process. In reviewing the state of the art the author said that the problem now before the manufacturing world was not so much the ways to produce aluminum cheaply, as the ways of utilizing the new metal in the arts. As to purity of manufacture, metal was placed upon the market as long ago as 1887-88 of 99.80 per cent. pure aluminum, and it is now possible by the electrolytic methods in use to obtain almost chemically pure aluminum. In fact the Pittsburg Reduction Co. has already made a good many tons of the metal of over 99.90 per cent. purity. As to cost, Mr. Hunt repeated the statement made in his lecture before the Boston Society of Arts, in 1891, that the ingot metal will be made by the Hall process within the next few years, at a cost of between 18 and 20 cts. per pound. The items of cost divide up about as follows: One-third for the ore, one-sixth for other materials used, one-third for the electrical current, one-twelfth for labor and superintendence and one-twelfth for general expenses, interest and repairs. Bauxite, containing in the hydrated oxide from 55 to 60 per cent. alumina and less than 10 per cent. of silica and iron with the remainder water, can now be delivered at Pittsburg in almost unlimited quantity for less than 1-2 cent per pound. The cost of other reagents than the ore, for carbon and for chemicals, at Pittsburg, is less than 5 cents per pound, and this estimate can be reduced to 3 cts. in a large plant with the most favorable arrangements. The item of electrical power may be also reduced in time, perhaps one-half, or heat alone may be substituted for it. But in this direction Mr. Hunt is confident that the increased expenditure for reagents and chemicals will nearly, if not quite, counterbalance the saving of electrical energy expended in the Hall process. There may also be a small saving in labor and general expenses by a process yielding metal more rapidly than by the present comparatively slow electrolytic process.

The average energy expended per pound of metal produced by the Pittsburg Reduction Co. is about 20 E. HP. hours, or each E. HP. hour of energy exerted upon the electrolyte yields about 22.7 grams of metal. Experience in use is adding to this efficiency, and a gain of at least 10 per cent is hoped for soon, and Mr. Hunt will not be satisfied until the gain in efficiency shall reach 25 per cent. over present rates.

The author then takes up the popular errors regarding the "aluminum age," which many hopeful writers hailed as about to rapidly supplant the "age of steel" in structures of all kinds. These people reasoning from the seeming abundance of the raw material and confusing section for section with equivalent weights, made all manner of absurd prophecies. They forgot to take into account the low elastic limit and the modulus of elasticity of aluminum, its lack of rigidity under compressive strains or its natural softness. Other writers go to the other extreme and publish to the world that the metal is soluble in certain acids, and hence jump to the conclusion that it is entirely unfit for use in culinary utensils; forgetting, seemingly, that muriatic, nitric and even sulphuric acids are not usually used as ingredients in gravies, etc. Another writer finds that the metal, in the form of foil, is soluble in weak solutions of certain acids; but he does not note that with the thickness used in utensils of other metals, the aluminum would at least withstand this action as well as do the metals in common use.

As to its use in cooking utensils, the author says that aluminum has neither taste nor odor, nor are its salts (in small quantities) especially poisonous as are the salts of other metals used. Salt water has but little more effect upon it than upon tin, copper or silver, and the same may be said of such solutions of vinegar as are usually used in cooking operations. Mr. Hunt has used aluminum cooking utensils in his own house for the past two years, and from his experience believes that this metal has a large future in this direction. Paraphrasing Mr. James Nasmyth, Mr. Hunt said that "common sense applied to the intelligent use of aluminum" would solve many problems connected with its future use.

The properties of aluminum which will probably give it the greatest availability in the arts, are:

1. Its relative lightness.
2. Its non-tarnishing quality as compared with many other metals; aluminum not being acted upon by sulphur fumes at all, and being very much more slowly oxidized by moist atmospheres than most of the metals.
3. Its extreme malleability.
4. Its easy casting qualities.
5. The influence of the metal in various alloys will give it advantages.
6. Its high tensile strength and elasticity when weight for weight of the metal is compared with other metals, and especially when alloyed with a small percentage of titanium, silver or copper and properly worked by being rolled or hammered or otherwise drawn down.
7. Its high specific heat and electrical and heat conductivity.

Unfortunately, aluminum is not, section for section, as has been widely claimed, comparatively a very strong metal. It is only about as strong under tensile strain, section for section, as cast iron, and has less than one-half the strength of wrought iron under ordinary conditions. Under compression, the metal, unfortunately, has a very low elastic limit, although its extreme ductility allows the metal to flow on itself so freely as to make it for special purposes a very safe metal to use in compression. The same remark applies to transverse tests on aluminum. It is not a rigid metal at all, and bends under transverse strains very readily. The following table will show about the average tensile and compressive tests of commercially pure aluminum, unannealed, as deduced from experiments at the Pittsburg Co.'s works:

	Pounds.
Elastic limit per sq. in. in tension, castings	5,000
" " " " sheet	12,000
" " " " wire..16,000 to	30,000
" " " " bars	10,000
Ulti'te strength per sq. in. in tension, castings	15,000
" " " " sheet	24,000
" " " " wire..30,000 to	65,000
" " " " bars	28,000
	Per cent.
Perc'age of reduction of area in tension, castings	10
" " " " " sheet	25
" " " " " wire	40
" " " " " bars	20
	Pounds.
Elastic limit per sq. in. under compression in cylinders, with length twice the diameter	3,500
Ulti'te strength per sq. in. under compression in cylinders, with length twice the diam.	12,000
Modulus of elasticity of cast alum. is about	11,000,000
" " " forged " "	15,000,000
" " resilience of cast " "	.1600
" " " forged " "	.2260

Under torsional stress in Thurston's torsional machine, the metal has much lower modulus of rigidity than iron or steel; its maximum shearing stress in castings being about 12,000, and in forgings about 16,000, being about that of pure copper. The angle of torsion is about equal to that of the softest steel.

Aluminum hardens under work, and wire of this metal has greater tensional strength than the rolled

metal, the proportion for No. 16 B. & S. wire being about as 65,000 lbs. to 23,500 lbs. per square inch for No. 20 sheet. Aluminum alloyed with a few per cent. of silver, titanium or copper, will produce a wire having a tensile strength of 80,000 lbs, and which will have, weight for weight with copper wire, an electrical conductivity of 170, to 100 for the copper. The specified gravity of aluminum is 2.56 in ingots and 2.64 in forged bars. The comparative weights of equal volumes of other metals are then as follows: Wrought iron is 2.90 times as heavy; structural steel, 2.95; copper, 3.60; ordinary high brass, 3.45; nickel, 3.50; silver, 4.00; lead, 4.80; gold, 7.70; and platinum weighs 8.60 times as much as aluminum. Most woods used for structural purposes are about one-third as heavy as aluminum. A cubic inch of cast aluminum weighs .092 lb., and in rolled sheet metal, .098 lb. The following table gives further useful comparisons:

	Weight in pounds of one cu. ft.	Tensile strength per sq. in.	Length of bar in feet able to support its own weight.
Cast iron	444	16,000	535
Ordinary gun bronze	525	36,000	9,893
Wrought iron plates	480	50,000	15,000
Aluminum plates	165	26,000	23,000
" " cold rolled	168	35,000	39,615
" " cast	160	15,000	13,251
" " forged	165	20,000	17,700

Mr. Hunt exhibited two sheets of copper and aluminum, about 6 ins. square, that had been nailed on the wooden sides of a schooner plying to the West Indies, and had been immersed in sea water for four months. The sheets weighed 1 lb. 2 3-4 oz. for the copper and 5 3-8 oz. for the aluminum, and the original thickness of the two sheets was 0.087 in. At the end of the time mentioned the aluminum had lost nothing in its thickness and the copper was only reduced to 0.086 in. The copper corroded most under the exposure, but unfortunately for the advantageous use of aluminum as a sheathing for ships, the barnacles thrived on the aluminum, owing to the relative non-corrosive qualities of that metal. But among the uses to which the new metal could be applied, says Mr. Hunt, may be mentioned the following: In structural purposes under water, to replace wrought iron and steel; for liners and shims upon masonry foundations, where it is less easily cut than lead and is more durable than tinned iron sheets, and as a more durable and satisfactory roofing than sheet copper. Its value as a conductor of heat and electricity has already been referred to. In this respect it stands fourth among metals, being only preceded by silver, copper and gold, the relative values being pure silver 100, copper of equal section 100, pure gold 78, and pure annealed aluminum 54.20.

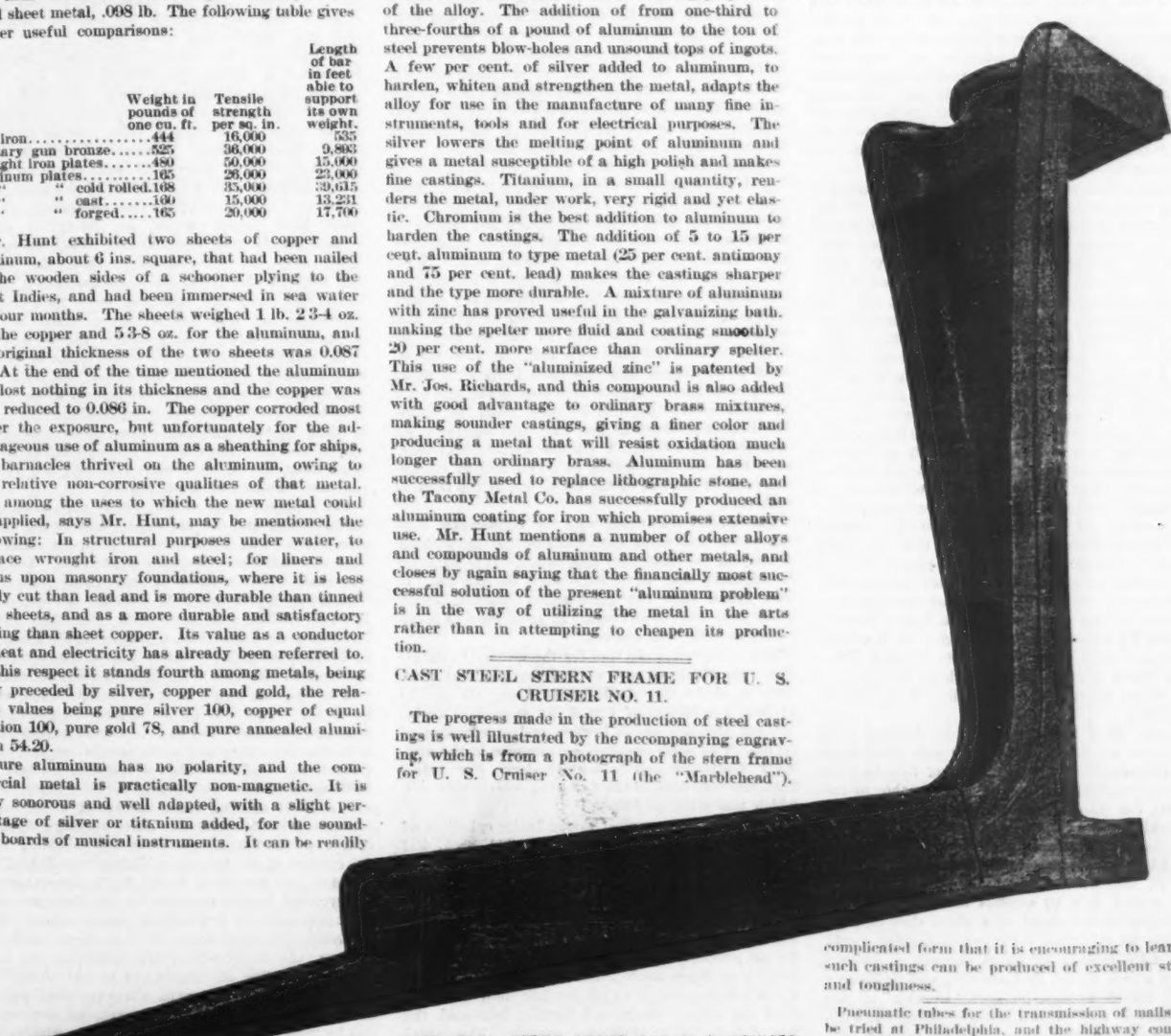
Pure aluminum has no polarity, and the commercial metal is practically non-magnetic. It is very sonorous and well adapted, with a slight percentage of silver or titanium added, for the sounding boards of musical instruments. It can be readily rolled into a sheet .0005 in. thick; beaten into foil nearly as thin as gold leaf, and drawn into the finest wire. In malleability it is exceeded only by gold and silver; but in ductility it stands seventh in the list. It can be rolled or hammered cold, but is most malleable and better treated at a temperature between 350 degrees and 400 degrees F. It can be easily welded by the electric process. The difficulty of soldering aluminum has been practically overcome by the invention, by Mr. Jos. Richards, of Philadelphia, of a cheap and satisfactory solder. Sound castings in dry sand molds or in metal chills can be made with some experience, but the shrinkage is considerably more than in brass, the first being 17-64 in. as compared with 3-32 in. per foot for brass.

Undoubtedly one of the greatest uses of aluminum in the arts will be as an alloy with other metals, as it adds to many metals valuable properties. Aluminum bronze, with 2 1-2 to 12 per cent. aluminum added to the copper, is one of the most dense, finest grained and strongest metals known, having also remarkable ductility as compared with its tensile strength. It can be made to stand 130,000 lbs. tensile strength with 5 per cent. elongation in 8 ins. The specific gravity of this bronze is about 7.50, and for cylinders to withstand high pressures it is probably the best metal yet known.

Aluminum added in a small quantity to ordinary tin-antimony-copper babbitt metal very considerably increases the durability and the wearing properties of the alloy. The addition of from one-third to three-fourths of a pound of aluminum to the ton of steel prevents blow-holes and unsound tops of ingots. A few per cent. of silver added to aluminum, to harden, whiten and strengthen the metal, adapts the alloy for use in the manufacture of many fine instruments, tools and for electrical purposes. The silver lowers the melting point of aluminum and gives a metal susceptible of a high polish and makes fine castings. Titanium, in a small quantity, renders the metal, under work, very rigid and yet elastic. Chromium is the best addition to aluminum to harden the castings. The addition of 5 to 15 per cent. aluminum to type metal (25 per cent. antimony and 75 per cent. lead) makes the castings sharper and the type more durable. A mixture of aluminum with zinc has proved useful in the galvanizing bath, making the spelter more fluid and coating smoothly 20 per cent. more surface than ordinary spelter. This use of the "aluminized zinc" is patented by Mr. Jos. Richards, and this compound is also added with good advantage to ordinary brass mixtures, making sounder castings, giving a finer color and producing a metal that will resist oxidation much longer than ordinary brass. Aluminum has been successfully used to replace lithographic stone, and the Tacony Metal Co. has successfully produced an aluminum coating for iron which promises extensive use. Mr. Hunt mentions a number of other alloys and compounds of aluminum and other metals, and closes by again saying that the financially most successful solution of the present "aluminum problem" is in the way of utilizing the metal in the arts rather than in attempting to cheapen its production.

CAST STEEL STERN FRAME FOR U. S. CRUISER NO. 11.

The progress made in the production of steel castings is well illustrated by the accompanying engraving, which is from a photograph of the stern frame for U. S. Cruiser No. 11 (the "Marblehead").



CAST STEEL STERN FRAME FOR U. S CRUISER NO. 11; WEIGHT, 9,213 LBS.

The casting is remarkable for its size (the shipped weight was 9,213 lbs.), for its intricate form, which would cause many engineers to distrust the possibility of its successful production in cast steel, and especially for its remarkable toughness, which is nearly equal to that of a fair quality of structural steel.

The casting was made by the Midvale Steel Co. The requirements of the Government specifications and the results obtained in the test were as follows:

	Requirements of specifications.	Result of test.
Ultimate tensile strength, lbs. per sq. in.	60,000	65,174
Per cent. of elongation in 2 ins.	15	22.2
Contraction of area, per cent.	..	43.7

The test was made on a specimen ½ in. diameter cut from the casting. In addition a bar 1 in. square was cut from the casting and bent cold to a right angle over a 3-in. round without showing the least sign of flaw or crack.

Another large steel casting of intricate design was recently made by the Midvale Co., for the new U. S. monitor "Puritan," which is now nearing completion at the Brooklyn Navy Yard. This casting, as noted in our issue of March 19, showed an elastic limit of 31,058 lbs. and an elongation of 25.10 per cent.

The production of metal of such good quality in a steel casting is an achievement on which the engineering profession at large is to be congratulated as well as the company which did the work. There have been so many failures in steel castings of complicated form that it is encouraging to learn that such castings can be produced of excellent strength and toughness.

Pneumatic tubes for the transmission of mails are to be tried at Philadelphia, and the highway committee of Councils has approved an ordinance permitting a company operating the Clay system of pneumatic transmission to lay a 6-in. tube between the main post office and the sub-station at Third and Chestnut Sts. for carriage of mail matter. The company offered to put up its system without expense to the Government, except for steam to operate it for the purpose of demonstrating its usefulness, and the Government has accepted the offer. The Leahe Co. made a similar offer, but uses a 24-in. pipe, and the government objected to furnishing so much steam power as a pipe of that size would require. A similar system is also to be tried at St. Louis, a double line of 4-in. tubes being laid for a distance of 3,000 ft. from the main post office.

Hydraulic power supply plant is being advertised for by the city authorities of Manchester, England, including 1½-in to 6-in. cast iron pipe, five steel boilers, mechanical stokers, coal conveying apparatus, pumping engines, accummualtors, and hydraulic cranes and elevators.

RACK TESTS TO DETERMINE STANDARD REQUIREMENTS FOR TRAIN BRAKES.

Some very interesting, and in some respects remarkable, tests were made at the works of the Westinghouse Air Brake Co. at Wilmerding, Pa., on Wednesday, April 27, to determine what constants it was reasonable to substitute in the schedule for a standard efficiency of the air brakes published in our last issue. The tests were made under the supervision, and in behalf of, the Master Car Builders' committee having that subject in charge, consisting of Godfrey W. Rhodes (Supt. M. P., C., B. & Q.), E. B. Wall (Supt. M. P., Penna. Co. S. W.), and George Gibbs (Mech. Eng., C., M. & St. P.).

The first two named of these gentlemen and a few others were present. The intention of the tests was not to determine the utmost which the Westinghouse or any other brake is capable of, but simply how much may reasonably be asked of any brake competing for patronage before it can be regarded as in good and regular standing. It is claimed that nearly all the performances below recorded can be and will be still further improved, although for ourselves we hardly see how much further improvement can reasonably be expected.

The tests were made on the regular Westinghouse testing rack, which represents every detail of the brake plant of a 50-car train, headed by an engine and tender. Very recently, however, a second rack of 50 cars has been superimposed upon the first, which can be cut in or out at pleasure, so that a 100-car train complete is now represented, and was for the first time (except in shop experiments) exhibited in these tests. Each brake cylinder has 41½ ft. of pipe between it and the next one, being some 7 ft. more pipe than the longest cars now in general use require. This was done in order to be prepared for any possible demand of the future.

We may add also that the brake cylinders and triples on this rack were chosen entirely at random from the stock, and that all triples sent out are now first tested on this rack and required to come up to substantially the same standard of performance.

The nominal velocity of sound at 60° F. is 1,120 ft. per second, from which it follows that the brake impulse, if transmitted through the pipes with the same velocity as sound is transmitted through the air, would require 3.4 seconds (not counting the engine and tender pipes) to pass through a 100-car train, and 1.7 seconds to pass through a 50-car train. These times represent the ultimate natural limit, beyond which it is impossible to hope for any increase in the velocity of transmission of an impulse through air.

But this speed of transmission is obtained only in the open air, when there is no side friction to check the progress of the undulating impulse. In pipes, especially small pipes, it is reasonable to expect that the transmission of a wave impulse will be somewhat slower, and experiment seems to show that it is so. Trautwine records in his "Pocket-Book" (Art. Sound) that tests in a 20-in. gas main 16,000 ft. long showed a velocity of exactly 1,000 ft. per second, just 16 seconds being required for transmission of the sound of a pistol shot through this pipe. At this rate, a like wave impulse would require 4.15 seconds to travel through a 100-car train (in a pipe 20 ins. in diameter), and 2,075 seconds to travel through 50 cars. In view of the much smaller size (2 ins. outside diameter, with numerous contractions) of a train-brake pipe, we judge that these figures give the truer ultimate limits which cannot be improved upon.

This limit was all but attained. The first test made was for Application Test (a) (see schedule published last week), under which the 50th car is required to show some movement of the piston in 3 seconds from the first movement of the engineer's valve, and 55 lbs. of pressure in 3½ seconds. This test was made several times with the 50-car train with the uniform result that 55 lbs. was attained in the 50th car in from 2½ to 2¾ seconds, as nearly as could be observed by stop-watches. Electric records showed that the interval between movement of the first piston and movement of the 50th piston varied from 2.18 to 2.20 seconds. This is not quite the same quantity as was observed by stop-watches, but is so near to it that human muscles are not quick enough to make any distinction between them, and it is probable that the greater portion of the observed difference is an effect of the "personal equation" of stop-watch observers. The 2.18 to 2.20 observation, moreover, is absolutely accurate, being measured electrically, and corresponds so closely to the 2.07 seconds computed above for the time required to transmit an air pulsation through a 20-in. pipe that we feel confident that the difference is due only to the greater retardation of the smaller pipe.

This conclusion is strengthened by the result of the similar test of the 100-car train, which we may give here in its natural place, out of its order in time. The average of six different timings of three different tests was a shade over 4¾ seconds, no single observation differing more than ¼ second from this average. This is but a fraction over 2 seconds more time for the added 50 cars, and indicates strongly that had this time also been taken electrically (which was not practicable) the observed time between the movement of the first and the 100th piston would not have exceeded 4.3 to 4.4 seconds, the interval determined above for the transmission of a sound impulse for a like distance through a 20-in. pipe being 4.15 seconds.

Nothing better than this, we are confident, can be hoped for or ever achieved through a 2-in. train pipe or less. It was a gratifying surprise to all present to see that, to all appearance, the brakes on a 100-car train could be handled with as great ease and certainty as on a 10-car or 50-car train. Heretofore there has been more or less doubt felt on this point; but not only did the brakes act equally well in an emergency application, but in release and in service applications also, so far as could be judged. No formal tests were made on these points, since it was apart from the main purpose in view, but several service applications were made, and with as much success as with 50 cars, while the entire 100 brakes released in less than one minute after pressure was let on. A curious feature was that, as a rule, the last brakes to go on and to release were not at the end of the train, but at the 60th to 80th cars.

The second test made was for Application Test (b), to see how many cars could be cut out without destroying the emergency application. It is proposed to stipulate that three cars must be cut out. It was found that the quick-action impulse would easily pass five cut-out cars. In prior tests as many as seven have been cut out.

The third test made was for the proposed graduation test, which as now worded requires that a reduction of 10 lbs. shall lightly apply all the 50 brakes; a reduction of 4 to 6 lbs. more give an increased pressure on all brakes, and a reduction of 30 lbs. in all shall equalize the pressure in the auxiliary reservoirs and brake cylinders. Far better than this was done in the following remarkable test, which was made as follows:

Gages had been applied to the brake cylinders of the 1st, 8th, 13th, 18th, 23d, 28th, 33d, 38th, 43d and 50th cars, and were mounted side by side at the head of the rack. The reduction of pressure was made in a perfectly uniform and very gentle way by opening a connection with a small air tank, which would hold enough air at one filling to reduce the air pressure in the train pipe by 1 to 3 lbs., depending on the pressure. There was also, of course, a small leakage going on all the time (how small we shall see later), which still further increased the rate of reduction in train-pipe pressure. The initial pressure, equalized throughout the apparatus, was 70 lbs. At successive reductions the results were as follows:

Reduction lbs.	T. pipe press. lbs.	1st car.	8th car.	Pressure in lbs. per sq. in. in the brake cylinder of the 13th car.	18th car.	23d car.	28th car.	33d car.	38th car.	43d car.	50th car.
5	65			All brakes on, but some pistons not quite home.							
8	62	23	18	18	18	14	13	10	15	14	16
9½	60½	31	22	23	23	20	18	15	23	23	25
13	57	out	31	33	30	25	25	20	34	33	35
14½	55½	of	36	40	35	31	28	23	40	40	42
17	53	or-	43	47	40	37	33	26	47	47	43
18	52	der.	52	50	43	40	37	30	52	52	47
19½	50½		51	51	48	43	40	30	53	50	49
Totals*.....			253	262	237	210	194	154	264	259	257

*We add the totals partly to illustrate a curious fact which may or may not have significance, that the brake seems to be somewhat more sensitive in its action near the head and rear of the train than in the middle; and partly to show the uniformity in the pressures obtained at head and rear.

The test was not continued beyond 20 lbs. reduction, as it had already far exceeded in severity the proposed test, and it was obvious that a slight further reduction would put on all brakes full. That the brake pressure did not reach as high as 55 lbs., which is that obtained in an emergency stop with 70 lbs. initial pressure, was doubtless due to the leakage which had taken place in the 15 or 20 minutes consumed in making the test, during which there was no accession of air to the train pipe.

The fourth test was to determine the sensitiveness of the emergency valve. The nature of the emergency valve is such, we may repeat for the benefit of careless readers, that a small and gentle reduction of pressure does not affect it, but any quick and large reduction of pressure causes it to open a direct passage from the train pipe to the brake cylinder and thus transmit the impulse backward with great rapidity and added force.

If there are to be several competitors in the brake business, it is obvious that there is likely to be more or less mixing of different brakes in service, and hence it is highly important that the sensitiveness of no make of emergency valve should exceed a certain fixed standard. Otherwise, if the car stood near the middle of a train, it might cause an emergency application on the rear half of the train when there was only a light service application on the front half; which would be likely to cause a bad shock and break-in-two. The emergency valve may be less sensitive than the standard with far less risk, since an emergency application will jump two to five or more cars, if their valves do not act, but as there might be five or more of these less sensitive valves together in the middle of a train, their effect might be to stop an emergency application midway of the train, and give only a service application behind them, which would be certain to cause a tremendous shock. It is thus highly important that these emergency valves, and also the engineer's brake valves which work them, should be brought and kept to a nearly constant standard of sensitiveness.

The proposed form of the test is that, with only engine tender and one car cut in, and 70 lbs. train-pipe pressure, an opening of —— ins. (in diameter) shall not cause an emergency application. The test was made with a number of brass plates perforated with holes varying in size by 1-64-in. An opening of 10-64-in. (5-32) was first tried, and then 11-64. Neither gave more than a service application. A 12-64-in. opening (3-16) barely caused the emergency application. It was, therefore, considered that a 5-32-in. opening would be a safe specification, as it is, so far as not causing an unintended emergency action is concerned, but as it is almost as objectionable that the emergency valve should not act when desired, it would seem that a specification that an 11-64 opening must not operate the emergency valve and a 13-64 opening must operate it would come nearer to what is required. These openings, we may add, were through plates about 1-16-in. thick, with the corners of the hole very slightly rounded. This rounding, we may note, though hardly observable to the eye, will largely increase the air discharge over what is possible with absolutely sharp corners. The difference will be as much as 20 to 25 per cent., at a guess. As sharp corners can always be had, and uniform rounding off cannot, we should advise the repetition of this test with sharp-cornered plates, and with a very accurate and extended determination by tests of many triples, of precisely what range of limits is reasonable and attainable in practice. The tests as yet made cannot be considered as at all adequate or decisive.

The fifth test was to determine the holding power of the brake in service applications, and gave remarkable and (to most of those present) quite unexpected results. The stipulated conditions were

that gages should be placed on the 1st, 25th and 50th car, but they were actually used on ten different cars, as above. The train-pipe pressure being 70 lbs., brakes were to be lightly applied so as to give as nearly as might be 15 lbs. pressure in the first brake cylinder. Pressure observations on all the cylinders were then to be made at once and after 5, 10 and 15 minutes. The apparent expectation was that at the end of that time the brake pressure would have almost or quite leaked off, as all supply of fresh air is cut off from the train-pipe, and there is a great area for leakage around the leather-packed brake pistons. As a matter of fact, however, during 35 instead of 15 minutes the pressure continued to rise instead of fall, and at the end of that time the train-pipe and (most of the) brake cylinders, as presumably the auxiliary reservoirs also (though there were no gages on these), had a nearly uniform pressure of 43 lbs., indicating that in the aggregate perhaps 20 lbs. of pressure had leaked from the brake plant in 35 minutes; but that the leakage was faster into the brake cylinders than out of them. The following is the record in detail for every fifth car in the train:

	Pressure in brake cylinder at end of:							
	0m.	5m.	10m.	15m.	20m.	25m.	30m.	35m.
Tr. pipe lbs.	62	57½	53	50	47	45	43	42
Car 1.....	16¼	27	41	49	48	47	44	43
" 8.....	15	24	33	38	40	47	44	43
" 13.....	12	22	33	42	43	46	44	43
" 18.....	15	22	30	33	33	33	32	30
" 23.....	11	19	27	33	34	34	34	33
" 28.....	7	19	24	28	30	30	31	30
" 33.....	8	12	13	14	14	12	12	11
" 38.....	16	25	40	50	49	48	46	44
" 43.....	13	27	42	52	49	47	45	43
" 50.....	12	23	31	38	40	38	38	37
Mean	15.5	22.0	31 7	37.7	38.1	38.2	37.0	35.7

At the conclusion of this test eight cars had come off, as an effect of the approximation of the train-pipe and brake cylinder pressures. In another five minutes most of the remaining brakes would probably have come off; but this effect could be checked by letting a little more air out of the pipes if desired.

This table, if its indications can be relied on as generally applicable (and we see no reason why it should not), shows a very satisfactory working. It indicates in brief that, if the brakes be put on ever so lightly and the train-pipe thus closed against further accessions of air, there will be a gradual leakage from the auxiliary reservoir into the brake cylinder in excess of that past the leather-packed brake pistons, which in about ten minutes' time will bring the brake pressure up to about two-thirds of the emergency maximum, and hold it there for 20 to 30 minutes. A very considerable increase in the rate of leakage past the brake pistons must occur before there can be any danger of the brake pressures falling below that originally applied, in descending any grade less than 10 miles long. The showing would be still more satisfactory, perhaps, if the rate of leakage into the brake cylinder were not quite so great, but a lot of old brake pistons would doubtless leak more than these did.

A similar test of the holding power of the brake after an emergency instead of service application is included in the proposed standard schedule, but was not made and seems hardly important, since all that is asked of an emergency application of any brake is to stop the train in a few seconds, and thereafter release easily. This part of the schedule, therefore (5 b), seems hardly important.

Next came the important release test, from which so much trouble has arisen lately. The proposed conditions are that with 160 lbs. boiler pressure, main reservoir cut out, 8-in. pump with 7½-in. air cylinder, and 70 lbs. train pipe pressure, the train-pipe is to be charged up to —— lbs., "and a record of all brakes released taken," which last clause, of course, makes this not an actual specification of a standard requirement, but a schedule for a test to determine such requirements.

As this test was actually made, and as it would seem best that it should always be made, a perforated diaphragm was used to admit air. The engineer's valve was first opened wide for an emergency application, and left open until the train-pipe was completely emptied of air. It is of interest to note that, although the emergency application was complete in 2¾ seconds after the valve was opened, it required no less than 2 min. 20 sec. for the pipes to completely empty themselves of air. This having been done, a pressure of 90 lbs. was maintained against a diaphragm perforated by a hole of 1-16-in. diameter, with the sharp edges slightly rounded off, through which alone air was supplied to the train pipe. It was hardly expected that so small a hole would suffice to pass enough air to exceed the leakage after the pressure had risen somewhat, and when we contrast this aperture with the large area for leakage in a 50-car rack, the doubt was natural. It proved sufficient, however, and no other aperture was tried. In 8 minutes 37 lbs. pressure had been obtained, and the first two brakes came off. The complete record of the test was as follows:

Time from begin'g pump'g, min.	Total No. of brakes, off.	Train pipe press., lbs.	Time from begin'g pump'g, min.	Total No. of brakes. off.	Train pipe press., lbs.
8	2	37	23	38	..
9	6	..	24	41	57
10	7	43	25	44	57
11	10	45	26	44	..
12	14	..	27	44	..
13	17	49	28	45	59
14	18	..	29	45	..
15	24	50	30	45	..
16	27	52	31	45	..
17	27	..	32	45	62
18	28	53	33	45	..
19	30	54	34	45	..
20	32	..	35	45	..
21	35	..	36	46	63
22	38	57			

(The remaining four brakes had equalized by leakage and could not release. A very slight quick reduction of about 2 lbs., however, released them.)

This test is greatly more severe than any which it has ever been proposed to exact.

The seventh and last test was to determine the time of charging one auxiliary reservoir, after completely bleeding it. It is essential that this should not take place too slowly, or it may not recharge quickly enough, and still more essential that it should not take place too quickly, or it may bleed the train pipe so rapidly as to apply the forward brakes again after they have been released.

In the test, one brake was first cut out and bled. Then 90 lbs. was let into the train pipe and the brake cut in again. The auxiliary reservoir gage began to move in 10 seconds; in 30 seconds there was 40 lbs. pressure: in 45 seconds 60 lbs. pressure and in 57 seconds 70 lbs. pressure. This test was not repeated, but the large experience of the Westinghouse Air Brake Co. is understood to indicate that the time of recharging under these conditions should not be less than 45 nor more than 60 seconds, and this is likely to be prescribed.

While these tests cannot be considered as finally settling all doubtful points, they do clearly indicate about what may be demanded, and hence, in our judgment, about what should be demanded, as we have more fully noted in another column.

A train of 20 Forney tank locomotives was sent to Chicago from the Baldwin Locomotive Works, Philadelphia, in April. The engines are for the Chicago & South Side elevated railway, and are of the Vauclain four-cylinder compound system. Their dimensions were given in our issue of Feb. 20. The train was hauled by a ten-wheel engine of the same four-cylinder compound system, described in the same article.

The gross and net earnings of railways in the United States for February and the first two months of 1892, according to the "Financial Chronicle," are as follows:

	February, (133 roads.) 1892.	1891.	Inc. per cent.
Gross earnings.....	$58,187,606	$50,806,125	10.5
Oper. exp.....	41,758,217	37,165,297	9.6
Net earnings.....	$16,429,389	$13,640,828	20.4
	Jan. 1 to March 1, (131 roads.) 1892.	1891.	Inc. per cent.
Gross earnings.....	$114,988,317	$105,970,950	8.5
Oper. exp.....	84,096,627	77,110,148	9.06
Net earnings.....	$30,891,690	$28,860,802	7.03

This is a very favorable showing, both for February and the two months, but especially for February, which exhibits an increase in net earnings over last year's figures of 20.44 per cent. The gain is quite general all over the country, but is especially noticeable in the Northwestern group, the anthracite coal lines and the Middle States, where the increases are 54.38 per cent., 46.53 per cent. and 34.22 per cent. respectively. The Southern roads, which have been showing rather unfavorable results, have a gain of 16.65 per cent. There are also some unusually large increases shown by individual systems. Among the more important of these are: The Pennsylvania system with a gain of $513,145, and the Chicago, Burlington & Quincy system with a gain of $475,366.

PERSONALS.

Mr. L. M. Hastings has been appointed City Engineer at Cambridge, Mass.

Mr. A. S. Cooper has been elected City Engineer of West Superior, Wis.

Mr. A. W. Scoble has been elected Superintendent of Water-Works at Forth Worth, Tex.

Mr. W. P. Mason, irrigation and sewerage engineer, has opened an office in Bozeman, Mont.

Mr. Nicholas Kuhnen, President of the Davenport Water Co., Davenport, Ia., died April 22.

Mr. E. W. Frost has been appointed Superintendent of Water-Works at Colorado Springs, Colo.

Constable Bros., architects and engineers, New York, have removed to new offices at 22 East Sixteenth St.

Mr. H. Q. Sanderson, Chairman of the Water Commissioners of Springfield, Mass., since 1881, died on May 1.

Mr. George B. Jaynes has been appointed Resident Engineer of the Washington division of the Great Northern Ry.

Mr. O. L. Spencer, one of the superintendents of the Joliet, Ill., Rolling Mills, died recently. He was well known among rolling mill managers.

Mr. O. H. Peacock, City Engineer of Rochester, N. Y., has been appointed Superintending Engineer to the East Side Sewer Commission of that city.

Mr. Erastus O. Hill, for many years Superintendent of the Eastern Division of the New York, Lake Erie & Western R. R., died at Matamoras, Pa., April 29.

Mr. W. A. Stowell, Superintendent of Construction of the Concord & Montreal R. R., has resigned, and accepted the position of General Manager of the Montpelier & Wells River R. R.

Mr. Clark Johnston, of Rochester, N. Y., died April 25, at the age of 69. He was largely engaged as a contractor for railway construction, and was one of the builders of the Wabash Ry.

Mr. James E. Sague, Mechanical Superintendent of the railways in Jamaica, West Indies, has been appointed Assistant Superintendent of the Schenectady Locomotive Works, Schenectady, N. Y.

Mr. Edgar Van Etten, Superintendent of the Western division of the Lehigh Valley R. R., has resigned to accept the office of Assistant General Superintendent of the Rome, Watertown & Ogdensburg R. R.

Mr. C. B. Vorce has been appointed Principal Assistant Engineer of the Lake Shore Division of the Lake Shore & Michigan Southern Ry., with headquarters at Dunkirk, N. Y., vice Mr. A. Zook, resigned.

Mr. Eugene H. Cowles, Manager of the Cowles Electric Smelting & Aluminum Co., of Lockport, N. Y., died at El Paso, Tex., April 21. He was one of the inventors of the electric process of aluminum production.

Mr. A. Langstaff Johnston, M. Am. Soc. C. E., of Richmond, Va., has gone to New Orleans, La., as Chief Engineer of the New Orleans & Carrollton R. R. Co., which is to be changed to an electric line, as noted in our news columns.

Mr. S. Higgins, Division Master Mechanic of the New York, Lake Erie & Western R. R., at Meadville, Pa., has been appointed Assistant Superintendent of Motive Power of the lines west of Salamanca, with office at Cleveland, O.

Mr. Edgar Williams, consulting civil engineer, Chicago, has removed his office to the Rialto Building. He will make a specialty of preparing plans, specifications and estimates for water-works, sewerage systems, etc., and will superintend their construction.

Mr. E. C. Cooke and Mr. W. W. Read have opened a general engineering office at Cleveland, O., under the firm name of Cooke & Read. They will make a specialty of the designing, construction and operation of water-works, sewerage and municipal engineering.

Mr. T. N. Ely, General Superintendent of Motive Power of the Pennsylvania R. R., has retired to accept the position of Fourth Vice-President of the company. Mr. S. D. Casanave, Superintendent of Motive Power of the northwest system of the road, has been appointed to succeed Mr. Ely.

Sir James Joseph Allport, President of the Midland Ry. Co., of England, died recently at the age of 81. He was for several years General Manager, and introduced many of the advanced ideas which make this one of the best and most progressive railways in England. He was a director of the company for 27 years.

Prof. Henry C. Adams, of the University of Michigan, and statistician of the Interstate Commerce Commission (also special census agent for transportation statistics), has been appointed a lecturer on finance in the historical department of Johns Hopkins University, of which university he is a graduate, we believe.

Mr. W. S. Reed has opened an office in the Monad-

nock Building, Chicago, as a consulting and constructing engineer, making a specialty of designing and constructing water-works. He has been connected with Moffett, Hodgkins & Clarke since 1885, and was engineer of the water-works recently completed at Harvey, Ill.

Mr. Walter Katte, Chief Engineer of the New York Central R. R.; Mr. George Birdsall, Chief Engineer of the Public Works Department of New York; Mr. J. H. Haskin, Mr. C. W. Dayton and Mr. John Fox, have been appointed a commission for the raising of the railway bridge over the Harlem River at Fourth Ave., New York, and the necessary approaches.

Mr. Lee L. Dagron has opened an office in the Rookery Building, Chicago, as a civil and inspecting engineer, making a specialty of the inspection, construction and erection of bridges, buildings, cars, rails, etc. He was connected with the inspection of the Kill von Kull drawbridge for the Baltimore & Ohio R. R., the Ohio River bridge for the Terminal Co., at Wheeling, W. Va., and other important works.

Mr. D. W. Church has opened an office as a consulting engineer in the Monadnock Building, Chicago. Mr. Church was graduated from the Rensselaer Polytechnic Institute in 1877; was engineer in charge of Missouri River improvement work from 1878 to 1884, and from 1884 has been Professor of Civil Engineering at the Iowa State Agricultural College, at Ames, Ia., and engaged in iron work construction.

Prof. Mansfield Merriman, of Lehigh University, has been offered the chair of mathematics in the Chicago University at a salary of $7,000 a year. We are not informed whether he has accepted, but we presume he will do so, as the Chicago University is not only so well endowed as to be able to offer very liberal salaries, as the salaries of professors go, but is evidently going to be a very progressive and important educational institution. We rejoice that there are at last coming to be universities in this country able to offer something like adequate salaries to eminent professors. They will raise the average all around and thus in the end greatly aid the cause of sound education.

Mr. Theodore L. Woodruff, inventor of the sleeping car and builder of the first one ever constructed, was struck by a train and killed when attempting to cross the tracks of the West Jersey R. R. at Gloucester, N. J., May 2, in the 81st year of his age. Mr. Woodruff's patent was taken out in 1856-7, after the first car was built for the Terre Haute, Alton & St. Louis R. R. The coach provided for seats for 60 passengers, which made up into flat berths at night. The next sleepers built were four for the New York Central R. R. by Webster Wagner, who also died by accident in the famous Spuyten Duyvil disaster. Geo. M. Pullman built the first luxurious sleepers, catering to a latent taste for luxury which he was shrewd enough to appreciate, and hence was the most successful of the three, but he did not build his first car until 1859. Both Pullman and Wagner paid royalties to Woodruff. He was also the inventor of a patent propeller.

NEW PUBLICATIONS.

MAY MAGAZINES.—One of the features of this month's "Century" is the first instalment of Mrs. Mary Hallock Foote's new novel, in which the fortunes and misfortunes of an Idaho irrigation scheme and the engineers and promoters who are engaged in it, are depicted. Mrs. Foote draws a picture true to life of an engineer of foreign experience and reputation, who is unable to accept the makeshifts and flimsy methods necessary in the new country, and of his rivalry with his hustling American partner, whose "horse sense" beats the engineer's theories out of sight, at least at the opening of the story. We cannot forbear quoting the following description of the engineer, as given by the hustling ex-partner:

> Now you'll notice how Dunsmuir's training got away with him. Here, with no demand as yet for water, he used the same care in laying out his system as in India in a thickly settled country on a tail division where every inch of duty was required. Well, there never were such surveys made in this part of the country as Dunsmuir's. . . . . His cry was always that no work is so expensive as cheap work which has to be done over. I couldn't gainsay him on technical grounds. What I did urge was this: Put your men on the easy part of the line and you can show our people when they come out here, two miles of ditch, that will have cost no more than half a mile up there in the canyon. But Dunsmuir called this "jockeying the scheme." . . . . . Did you ever see a magnificent handler of money who didn't think himself a great economist?

Two other articles in the "Century" deserving especial praise are "Architecture at the World's Columbian Exposition," by Henry Van Brunt, and a paper on yachting and yacht design by F. W. Pangborn.

In "Scribner's" the sending of the first telegraphic news message is described by Alfred W. Kirk, who had charge of the disbursement of the $30,000 appropriated by Congress to aid Morse in developing his invention. Prof. N. S. Shaler describes in a paper accompanied with some excellent illustrations the action of waves upon the sea coast in leveling cliffs, excavating caves and eating away beaches. Mr. Thomas C. Clarke has a paper on "Rapid Transit in Cities—The Problem," which is to be followed next month by "The Solution," by the same author. In the present number Mr. Clarke describes the rapid transit problem as it is presented in Berlin, Paris, London, New York, Boston and Chicago, with maps of the congested districts. On the basis of number of trips per inhabitant, European cities are far behind American. In Boston the average annual trip per person is 263, in New York 248, in Chicago, including steam railways 234, and in Philadelphia 160. Principal foreign cities show: London 186, Paris 130, including cabs; and Berlin 104.

Harper's contains this month an excellent paper on the Dakotas, by Julian Ralph, and a finely illustrated description of "The German Army of To-day," which is so systematically and carefully prepared as to be of real professional, as well as popular interest. It is interesting to note that the death rate of the German army in peace is smaller than that of any other standing army. Notwithstanding her magnificent military equipment, the amount spent by Germany on her army is less than that spent by France and Russia, but little in excess of Great Britain's outlay, and only double the cost of our own diminutive, but expensive army.

"The Californian Illustrated Magazine" has some admirable articles this month, among which we notice especially descriptions of Palm Valley and of the Napa soda springs, two Californian curiosities, and of the great glaciers on the southern coast of Alaska, beside which Alpine glaciers are hardly worth notice. The great Muir glacier covers an area of 1,200 sq. miles, a tract nearly as large as the state of Rhode Island.

Those who have listened with some disbelief to the reports of the extent of the Russian famine, should read the account of it in this month's "North American Review," by our Minister to Russia, Hon. Charles Emory Smith. The area over which the famine prevails is ten times as large as the state of New York, and contains a population of over 30,000,000. One-half of this vast number are in utter destitution, without food or the means of getting it, and must have perished had not continuous succor been provided for months. Of the remaining population, a large proportion can sustain themselves to the next harvest only in the most precarious way. The Russian Government has already spent about $100,000,000, and the contributions of private charity all over Russia and in foreign nations, have largely increased this amount. The direct and indirect loss to Russia by the famine will amount to over $500,000,000. In the extent of the population affected, the Russian famine must be reckoned the greatest calamity of this sort which a civilized nation has ever suffered. In the brief "notes" in the latter part of the magazine, Mr. A. J. Cassatt, of the Pennsylvania R. R., advocates cheap cab service for American cities, and describes the successful experiment of the Pennsylvania R. R. in this direction in Philadelphia. Col. R. T. Auchmuty tells of the New York trade schools, where over 500 boys are learning to be mechanics.

Among the notes in the "Popular Science Monthly" there is one on the experiments which Nikola Tesla has recently been performing in London, in which that distinguished inventor is referred to as "the able lieutenant of Mr. Edison." The note is abstracted from the London "Spectator," whose ignorance of Tesla's famous career is perhaps excusable; but it is a pity for the leading American scientific periodical to assist in giving currency to such a blunder. We regret to say, however, that its editors seem to have a decided preference for papers and notes of foreign origin. If it ever referred to Tesla's original experiments, made in this country last year before the electrical engineers, we do not recall the fact.

"The Forum" has a paper on the Standard Oil Trust, written by the Trust's solicitor, S. C. T. Dodd, in which some of the economies which the Trust have accomplished are set forth. The actual cost of refining has been reduced about 66 per cent. since 1872. Barrels cost $1.25 each against $2.35 in 1872, and sulphuric acid, which cost formerly $1.25 per 100 lbs., is now made by the Standard Oil Co. at a cost of 8 cts. per 100 lbs. What these last figures mean is rather puzzling. Sulphuric acid is quoted in the market at $1.60 to $2.00 per 100 lbs. Wyatt, in his "Phosphates of Florida," gives the actual cost of producing sulphuric acid of 50° B. at 38 cts. and 30 cts. per 100 lbs., according as brimstone or pyrites is used as the raw material. If Mr. Dodd means that the Standard Oil Co. recovers its acid after using at a cost of 8 cts. per 100 lbs. he should say so, for to claim to have reduced the cost of actual production of a standard article like acid to a sixteenth of what it was 20 years ago, is decidedly misleading. As for other economies effected, it is certainly greatly to the credit of the Trust that they have been accomplished; but it is well to remember that similar improvements and economies have been put in force during that time in many lines of industry besides oil refining. Edward Atkinson writes in this number on "Incalculable Room for Immigrants," arguing that the unoccupied and partially cultivated lands of the United States are sufficient to provide food and homes for all Europe can send us. Perhaps they are, but before the argument of the author is proven it would be necessary to establish at least equally well the incalculable digestive powers of American civilization. That those powers are great is established. That they are sufficient to enable us to digest all the emigrants that Europe can send us at a cost of $7 for a two weeks' voyage (which is the probable rate next year from Italy) is by no means established. Mr. E. P. North's paper on "Ocean Traffic by the Erie Canal," we have commented on elsewhere.

REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF MAINE, for the year ending June 30, 1891. Pub. Doc., 8vo., pp. 447; illustrated.

This report is somewhat larger than those for previous years and contains several very good engravings of some of the more important bridges and other railway structures in the state. There is little calling for attention with the exception of the few pages taken up with the discussion of railway legislation. The commission takes the surprising stand that the various attempts of the Federal and State Governments to regulate railway traffic are unwise, and that the results of such legislation are detrimental to the best interests of the people; and implies, not to say asserts, that such regulation is largely responsible for the small rates of dividends paid by railways in the Southern and Western states as compared with those paid by railways in the New England states. This is not a tenable position. The argument that because no regulation of rates is exercised in Maine, and yet no complaints have arisen, no such regulation is necessary in the South and West, is by no means sound. The conditions are entirely different. No one questions that investors in railway properties "are entitled to a reasonable income from money invested," but to attribute the unprofitable operations of railways in certain sections of the country to the laws regulating traffic shows a great misconception of the true state of affairs.

ECONOMIES IN MAINTENANCE OF WAY.—Benjamin Reece, M. Am. Soc. C. E. The Q. & C. Co., Chicago; pamph., 12mo., pp. 33.

This is a reprint of the paper read by Mr. Reece before the New York Railroad Club at its March meeting, and noted in our issue of March 26.

BULLETIN DE LA COMMISSION INTERNATIONALE DU CONGRES DES CHEMINS DE FER, Vol. IV., No. 1, January, 1892. 8vo., pp. 156.

This number contains a paper on "The Distribution of Empty Freight Cars," by Mr. Henry Lambert, General Manager of the Great Western Ry., England, with drawings of the English standard type of open freight car. The various rules in regard to mileage charges, demurrage, transit and detention, forwarding, etc., are given. This paper, in French and English, occupies 120 pages. Some particulars are given in regard to English and French locomotive boilers.

LES CHEMINS DE FER ET LES TRAMWAYS.—(Railways and Street Railways). Construction, Operation and Traction. Track, stations, signals and safety appliances; speed of trains; locomotives and cars; metropolitan, mountain, and narrow gage railways; electric railways. By Adolphe Schoeller, Engineer of Arts and Manufactures, Inspector of the Northern Railway, Paris, 1892. J. B. Bailliere & Son, 12 mo.; pp. 361.; 90 illustrations, 3.50 francs.

The object of this book, as stated in the introduction, is to present the latest improvements and progress in the construction and operation of railways in France and other countries, and its descriptions are general rather than detailed. The illustrations include cuts of two American locomotives, steam snow shovel, cable and electric railways. The arrangment by chapters is as follows: 1, track; 2 and 3, passenger and freight stations; 4 and 5, signals and interlocking; 6, telegraph and telephone; 7, 8, 9 and 10, classification, comparative speed and operation of trains; 11, block system; 12, locomotives; 13, passenger and freight cars; 14, brakes; 15, metropolitan railways; 16, mountain railways; 19, London underground electric railway.

TRADE PUBLICATIONS.

PORTABLE AND LIGHT RAILWAYS, ROLLING STOCK AND RAILWAY APPLIANCES.—Illustrated Catalogue of Dick, Kerr & Co., London, England. Oblong, 4to., pp. 116.

This is an illustrated and descriptive catalogue of railway material, equipment and appliances for portable, semi-portable and fixed rolling stock. It includes steel rails and ties, fastenings, switches and frogs, turntables, traversers, locomotives and cars, steel dump cars, water tanks, bridges and roofs, machine tools, cranes, steam and gas engines, river steamers, and track material and equipment for horse and cable railways. The company's system of cable railway construction, as employed at Edinburgh, Scotland, was described in our issue of July 20, 1889. The cost for

portable railway track, consisting of steel rails riveted to steel ties, forming sections 12 to 15 ft. long, ranges from $1,450 per mile with 10-lb. rails and 16 ins., gage, to $2,475 per mile with 20-lb. rails and 30 ins. gage, and $2,975 per mile with 24-lb. rails and meter gage. These different forms of track are in extensive use in England, the colonies, and foreign countries for contractors' use, plantations, light railways, etc. Box and flat cars, about 10x5 ft. on four-wheel trucks, cost from $170 to $250 for 20 ins. and meter gage for the former, and $110 to $130 for the latter. Stamped steel ties, of a form used in India, cost about 55 cts. each for 2-ft. gage; 81 for meter gage.

STEREOPTICONS; MICROSCOPES; PHYSICAL SCIENCE; ELECTRO-THERAPEUTICAL APPARATUS. Catalogues of the McIntosh Battery & Optical Co., Chicago.

These four publications, with from 100 to 300 pages each, and aggregating 700 8vo pages, contain full descriptions, price list and cuts of the above mentioned apparatus. The one on stereopticons gives 200 pages to a list of lantern slides of many subjects from all parts of the world.

SOCIETY PROCEEDINGS.

DENVER SOCIETY OF CIVIL ENGINEERS.—At the meeting on April 27 two papers were presented: "Various Methods of Ventilating Tunnels," by Mr. Thomas Withers; and "Electric and Cable Railways in Denver," by Mr. F. H. Whiting.

CENTRAL RAILWAY CLUB.—At a special meeting held at Buffalo, April 27, the committee to which was referred the matter of facilitating the unloading of freight cars with injuries not so serious as to make them unsafe to run, made its report. They favored the adoption of a card to be used only for local business, permitting the "bad order" car to run to its destination for unloading, but requiring its return as soon as empty. After lengthy discussion and considerable opposition the report of the committee was accepted, and they were instructed to obtain from the heads of mechanical departments of Buffalo railways their consent to the proposed arrangement. Amendments to the Rules of Interchange were presented by a committee, and several were accepted, none of them, however, of much importance. The club will not meet again until September.

TEXAS STATE SURVEYORS' ASSOCIATION.—The annual convention was held at Austin, Tex., in April, President Brown, of Lampasas, in the chair; Secretary, Mr. Finner, of De Witt. A petition was formulated, which calls for a law to compel all applications for land to be filed with the county surveyor instead of at the general land office. This is to prevent the complications which often arise in communications from a distance with the general office here. The plan finally adopted provides that the mayor shall at once notify the commissioner of the application, so that a double file may be kept. A resolution proposing to allow county surveyors $5 for each reclassification of a section of land was voted down as being out of date, nearly all lands having been lately reclassified. Another demand for the abolition of state surveyors was adopted. The claim is that state officers are sent to interfere with the work of the county surveyor and often to do much poorer work. Commissioner McGaughey concurred in both of these propositions, and promised that if the demands were specifically and sensibly formulated, he would go before the legislative committee and urge their claims.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—The following is from the Society's bulletin of April 28: At the meeting on May 4, papers on "The Hydrography of the Potomac Basin," by Mr. C. C. Babb, and on "A New Method of Tunnel Alinement," by H. F. Dunham, will be read and discussed.

The paper by Mr. Babb is the result of a year's study of the subject in connection with the geologic and hydrographic divisions of the Geological Survey, and describes gagings of the Potomac made at Chain Bridge, three miles above Washington. The trolley method and Haskell electric meter were used, and the effect of tide eliminated by taking three readings each day. From five direct and several partial gagings of flood discharges, a curve was drawn from which discharges for each tenth of a foot of gage height have been tabulated. The characteristic features of the Potomac, and the method by which a rating curve has been obtained at Great Falls by comparison of results at two points, are described. Tables are given of monthly flows; maximum, minimum and mean discharge in "second-feet"; the rain-fall and depth of run-off, and the second-feet per square mile of area drained. Diagrams are given covering the whole range of the observations, and comparison made with similar diagrams of the Yellowstone River. "Sediment curves" are also given, showing the condition of the water at various stages and periods.

The paper by Mr. Dunham, after referring to the usual method of giving line and grade in a timbered tunnel, and the difficulties incident thereto, describes one which he has sucessfully used. A common wye level, placed on a permanent platform at a convenient height and near one side of the tunnel, was used to give both line and grade. A permanent target similarly situated was used as a backsight, the telescope reversed in the wyes, and line and grade given on a plummet lamp supported by a gage board or bracket, which was held upon the corner of the wall plate. The rodman holding the gage board directed the vertical and horizontal movement of the wall plate until it was secured in place on one side of the tunnel, and then with a larger gage board and a spirit level the position of the plate on the other side was easily determined. Little interruption to the work of excavation was given by the work of the engineers, which was accomplished in about one-fourth of the time required by the old method.

At the meeting on May 18, a paper will be read on "Hot Tests for Determining Change of Volume in Portland Cement," by W. W. Maclay.

AMERICAN SOCIETY OF IRRIGATION ENGINEERS.—At the close of the Irrigation Congress in Salt Lake City, Sept. 18, 1891, a few engineers who were delegates were called together by Prof. L. G. Carpenter, of Colorado, who suggested the organization of a society of irrigation engineers. Officers were elected and the Board of Directors was instructed to draft a constitution and by-laws and send it to the members for suggestions and additions. It seemed evident that an organization of men interested in the physical problems of the arid regions would be of benefit to its members, and also that an organized body of skilled engineers with experience in the peculiar work of arid land reclamation was almost a necessity, not for the increase of their own knowledge only, but for the security of those investing their time and money in reclamation or irrigation works.

The members of the Board of Directors reside in California, Colorado, Utah and Idaho, and being engineers, have many duties and little time for traveling, so that it was February before a meeting was arranged. In the meantime the secretary had received many letters and much encouragement from irrigation engineers, and when the board met it was found that 200 members were assured for the society, including several from Europe, India, Egypt, Mexico and South America. The Board of Directors drew up a constitution and by-laws, and printed copies will be sent out.

The Constitution of the Society admits of: Members, those who are professional irrigation engineers; Associates, those who, by their knowledge and experience, can co-operate with engineers in the work or irrigation; Juniors, young men who intend to become irrigation engineers. There will be one annual meeting of the Society, and it is hoped that there can also be one meeting each year in San Francisco, Denver, Salt Lake, and possibly in other cities north or south. At these meetings papers will be read and discussed in the usual manner.

It is the intention to have every one in the Society, at least once a year, give in writing something of his experience or something of his knowledge which will be of benefit. These will be published annually in book form, and this gathered experience and knowledge of irrigation engineers and of men building and managing irrigation works should be of great value and interest not only to members of the Society, but also to those who are interested in the great problems of irrigation, forestry and cognate subjects.

Arthur D. Foote, President.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—The Chemical Section held its meeting March 24, Prof. J. W. Langley, President, in the chair; Mr. James Camp, Secretary. A paper was read by Mr. James O. Handy, on "A Rapid Method for Phosphorus Determination in Iron, Steel and Ores."

No method of determining phosphorus will ever find favor among chemists unless it possesses advantages over existing methods. My belief that the process which I have worked out is a step in this direction is my reason for now describing it. I have proved by a great many experiments that several of the steps of Mr. Manby's process can either be safely dropped or simply modified, and a rapid and satisfactory process produced.

My method consists of the following points: (a) Separation of the phosphorus as pure phospho-molybdate of ammonium, by washing with neutral potassium nitrate solution, after the regular washing with 1 per cent. nitric acid; (b) Solution of the pure phospho-molybdate in a measured volume of a standard sodium hydrate solution. A definite quantity of the alkali is taken up in neutralizing the phospho-molybdate; (c), titration of the excess of sodium hydrate by means of standard nitric acid. Phenol phtalein is used as the indicator. The end reaction is very distinct. Duplicate analysis gave closely concordant results, which agree exactly with determinations of phosphorus by gravimetric methods. Without any special appliances, and without use of suction, analysis can easily be done in 30 minutes. I am confident that this time can be shortened one-half. An analysis has in fact just been done in 17 minutes. (March 28.) The first part of the process is essentially that of Dr. Drown (A. I. M. E., June, 1889). I have confirmed by long experience Dr. Drown's statement that sugar can be safely used as a reducing agent in the process. Clemens Jones substitutes ferrous sulphate, but I find that it requires several times as much ferrous sulphate as sugar for reduction, and that the sugar produces no ill effects.

The regular monthly meeting of the society was held April 19, Mr. Alfred E. Hunt, President, in the chair. Mr. R. N. Clark, Secretary. A paper was read by Mr. G. S. Davison, on "Discharge Observations of Large Streams." The paper reviewed in brief the work accomplished by separate investigations, beginning in the 17th century, and closing to date, and giving details from the author's personal work when engaged as an assistant engineer under the Mississippi River Commission during 1879 and 1880, when he was detailed for duty at Fulton, Tenn., about two miles below Fort Pillow. A full description was given of the character and management of the floats, both single and double, as well as of the method of obtaining mid-depth velocity. The irregularity of all results obtained from different known formulas was shown. The paper concluded with the following resume:

As to the particular system to be used, we believe the double float system, carefully conducted, will give good results up to a velocity of 10 ft. per second. Current meters, carefully rated for coefficients, and used with chronograph, will give very accurate results. They are held stationary at a point in the section while in use. The former depends on the average of its approach to, and departure from, the discharge section for its main velocity through the same, while the latter gives the condition of things immediately at the section. The meter cannot be used for high velocities, as in swift currents it would be difficult to hold in place the craft from which the observation must be taken. In the experiments at Burlington, Ia., comparisons of these systems were made, showing very slight differences, so slight as to practically give the same results. The current meters recorded the actual pulsations of the water, thus representing very slight change in velocity. All the oscillations within the path of a moving float are averaged.

At the meeting on May the committee on rail joints will make its final report, and Mr. John Seaver will read a paper on "Iron Mill Buildings."

COMING TECHNICAL MEETINGS.

SWEDISH ENGINEERS' CLUB.
May 7. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.

NORTHWEST RAILROAD CLUB.
May 7. Union Station, St. Paul.

ENGINEERS' CLUB OF PHILADELPHIA.
May 7. 1122 Girard St. Secy., J. C. Trautwine.

ENGINEERS' CLUB OF KANSAS CITY.
May 9. Baird Building. Secy., H. Goldmark.

WISCONSIN POLYTECHNIC SOCIETY.
May 9. Loan & Trust Bldg., Milwaukee. Secy., M. Shinke.

ATLANTA SOCIETY OF CIVIL ENGINEERS.
May 10. Secy., Parker N. Black, Capitol Block.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
May 10. Secy., C. S. Howe, Case Library Building.

NORTHWESTERN SOCIETY OF ENGINEERS.
May 10. Occidental Block, Seattle. Secy., E. H. Warner.

DENVER SOCIETY OF CIVIL ENGINEERS.
May 10. Secy., Geo. H. Angell, Jacobson Block.

NEW ENGLAND RAILROAD CLUB.
May 11. United States Hotel, Boston. Secy., F. M. Curtis.

ENGINEERING ASSOCIATION OF THE SOUTHWEST.
May 12. Secy., O. H. Landreth, Nashville, Tenn.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
May 12. Secy., Edward Mead, Norton Building.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
May 13. Union Station, St. Paul.

TECHNICAL SOCIETY OF NEW YORK.
May 14. 194 Third Ave. Secy., H. Schreiter.

ASSOCIATION OF ENGINEERS OF VIRGINIA.
May 14. At Roanoke. Secy., J. E. Schick, Roanoke, Va.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 16 to 20. San Francisco, Cal. Secy., F. R. Hutton, 12 W. 31st St., New York.

AMERICAN WATER-WORKS ASSOCIATION.
May 16. Secy., J. H. Decker, East Orange, N. J.

WESTERN RAILWAY CLUB.
May 17. Rookery Building, Chicago. Secy., W. H. Marshall.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
May 17. Secy., R. N. Clark, Pittsburg, Pa.

BOSTON SOCIETY OF CIVIL ENGINEERS.
May 18. Secy., S. E. Tinkham, City Hall.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
May 18. Secy., F. Collingwood, 127 East 23d St., New York.
June 8. Annual Convention. Old Point Comfort, Va.

ENGINEERS' CLUB OF ST. LOUIS.
May 18. Secy., Arthur Thacher, Odd Fellows' Building.

ENGINEERS' CLUB OF CINCINNATI.
May 19. Secy., J. F. Wilson.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
May 19. Secy., T. G. Philfeldt, 118 Adams St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
May 19. At Atlanta, Ga. Secy., F. A. Charlot, Macon, Ga.

NEW YORK RAILROAD CLUB.
May 19. At 12 W. 31st St. Secy., H. G. Prout, 73 Broadway.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
May 19. Secy., C. H. McLeod, Montreal, P. Q.

MONTANA SOCIETY OF CIVIL ENGINEERS.
May 21. Secy., F. D. Jones, Helena.

CENTRAL RAILWAY CLUB OF BUFFALO.
May 25. Secy., Jas. Macbeth.

WESTERN SOCIETY OF ENGINEERS.
June 1. Secy., J. W. Weston, 230 La Salle St., Chicago.

ENGINEERS' CLUB OF MINNEAPOLIS.
June 2. Public Library Bldg. Secy., F. W. Cappelen.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
June 3. Secy., E. K. Smoot, 803 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
June 3. Secy., O. von Geldern, 519 Market St., San Francisco.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
June 6. Secy., C. L. Annan.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 6, 7. Grand Pacific Hotel, Chicago. Secy., R. W. Pope, New York.

NEW ENGLAND WATER-WORKS ASSOCIATION.
June 8, 9, 10. Holyoke, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.

AMERICAN RAILWAY MASTER MECHANICS' ASSOC'N.
June 20. Saratoga, N. Y. Secy., A. Sinclair, New York.

AMERICAN INSTITUTE OF MINING ENGINEERS.
June 21. Plattsburg, N. Y. Secy., R. W. Raymond, New York.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST..... .....BUSINESS MANAGER

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That English locomotives sometimes make very large mileage, both per year and in total, is shown by the record of the "Charles Dickens" on the London & Northwestern Ry., which has made the round trip daily between Manchester and London (with occasional exceptions for repairs) since 1882; and on Sept. 10, 1891, completed its millionth mile. This is, perhaps, truthfully declared to be "a feat without parallel in the annals of railway traveling," as few engines complete their millionth mile, and fewer still do it in nine years, or at the rate of 111,000 miles per year. On the Pennsylvania Railroad, in 1885, the highest mileage which any passenger locomotive then had to its credit was 780,182 miles. Several had about 500,000 miles to their credit for ten years' service, and one had 41,510 miles for three months' work, or at the rate of 166,040 miles per year. The average of all passenger engines that year, however, was 45,936 miles (highest, 79,258), which is quite beyond any English precedent, and as several of the Western roads are far exceeding Eastern precedents in respect to locomotive mileage, it may be that some Western road has a locomotive in its service which has made a million miles in ten years. The New York Central has not, and it is likely to remain a very exceptional performance either in England or America until operating conditions have radically changed.

Two almost simultaneous railway accidents on the New York Central and the Pennsylvania railroads, happening in the first few minutes of May Day, illustrated how dense the traffic has grown to be on our main trunk lines, and how imperative it is to use on them only the best safety appliances. In both cases a wreck on one track obstructed the other also and caused a second wreck. The accident on the Central was a triple collision. One westbound train ran into another which had stopped to take water, and knocked a number of cars over on to the eastbound track, where they were run into a moment later by an eastbound train. An oil car set the wreck on fire and 25 loaded cars were destroyed, the cost of which would have paid for quite a section of the block signal plant which the Central is now erecting.

Almost at the same moment an eastbound Pennsylvania freight train was wrecked by broken brake gear, and it also blocked both tracks, right in the face of an approaching westbound mail train, which ran into the wreck before it could be signaled. A bad wreck resulted, which was also followed by a fire in which several express cars were consumed. Each of these accidents caused one death and several injuries.

The second halves of both of these disasters belong to a class which no conceivable kind of safety appliances can wholly eliminate, those in which one track is suddenly blocked by a wreck on another. There have always been many such accidents, and with the continued growth of traffic they must become relatively more and more frequent; but this makes it all the more important to avoid the primary accidents from which they must spring. The Central is at last doing what it can do to eliminate the first cause of its accident by installing a very perfect block system. The Pennsylvania is already blocked (though not in so perfect a way as the Central is to be blocked), but in common with most other roads has a much lower standard of security for freight brake attachments than for passenger. One cannot but think that the prevalent method of hanging freight brake gear so that loosened parts can fall and wreck a train is also a hopeful field for reform, since the way to it is neither long nor costly. Passenger wrecks from fallen brake gear are comparatively very rare.

Political economy and allied subjects do not seem to be generally considered as studies necessary to the engineering student in our technical schools. Doubtless in some of these schools such subjects could be taken up as electives if the student chose, provided he could find classes or lectures not conflicting with his other appointments. Few young men appreciate the value of general economic studies until they have had at least an elementary course in political economy. For this reason it would seem eminently proper to require every engineering student to take up political economy in his junior year, giving it sufficient study to gain familiarity with the most practical of its general principles. At the close of this compulsory study a lecture might well be given pointing out the relation of political economy and some of our present social problems to the engineer in practice. Investigations and courses of reading could be suggested for those who wished to pursue the subject further. In the senior year the student would be prepared to do more advanced work, if he so desired. Of course the ideal way would be for every engineer to first take a full college course in the so-called arts where all the political economy and similar studies necessary would be required. But this often is, or seems to be, impossible. If no more can be provided the engineering student, at least a few lectures may be offered him on those economic subjects most closely related to engineering, as, to name only one subject, the relations between municipalities and natural monopolies, a subject with which every engineer connected with city work should be familiar. There is promise of a good opportunity for engineering students to do either much or little of economic study at the University of Wisconsin, beginning with next year. At this institution Prof. Richard T. Ely, now associate professor of political economy in Johns Hopkins University, will soon be at the head of a school of economics, history and public law. The announcements regarding this school state that Dr. Albert Shaw, of New York City, will deliver before this school a two-weeks' course of lectures on cities, a course which every engineering student in the institution would do well to attend. Many of the colleges giving engineering instruction already have most excellent schools or instructors in political economy, so that the above suggestions can be easily carried out, as far as facilities are concerned.

STANDARD BRAKE AND COUPLER REQUIREMENTS.

The existing situation is somewhat critical in respect both to automatic freight brakes and automatic couplers. It is settled that they are to go rapidly into use. They are already in use on a very large percentage of the freight cars of the country, so that no change of type or material detail is now possible, nor does any one whose opinion is of moment desire such change. It is also settled, and becoming clearer every day, that there is to be a considerable number of competing manufactures of both brakes and couplers. The danger is, and it is a great one, that neither makers nor buyers will fully understand what is required, or what is possible, and so that many roads will be stocked up with a lot of inferior brakes and couplers, thus causing great trouble, which might all have been avoided had makers and buyers been informed in advance just what requirements could be and should be met, for good service. As the freight-car equipment of the country is practically a common stock to which each road contributes its proportion, "the injury of one is the concern of all" in a peculiar sense, in regard to it.

To obviate this difficulty by preparing a standard schedule of requirements, two carefully selected committees have been appointed by the Master Car Builders' Association, both of which held meetings in Pittsburg last week, with results chronicled last week as respects couplers, and this week as respects brakes. The last was by far the more important, both because some actual tests were made, and because the brake situation is the most serious. The chief danger as respects couplers is a money loss from bad quality or proportions. The same danger exists with brakes, with the further and far more serious one that admixture of different brakes in the same train may prevent any of them from working properly or safely. Fortunately, it is at the present moment much easier to state what can be and should be demanded before a competing brake is admitted to good and regular standing than to do the same thing for couplers. In fact, keeping in view all the facts of the existing situation, it seems to us that but little more work remains to be done (and that merely of detail) before a sufficiently exact schedule can be made for all practical requirements. We may briefly outline the requirements which seem to us essential as follows:

The plain English of the existing situation is that the Westinghouse brake has been adopted as the standard, with a general invitation to all other brakes which can be used interchangeably with that, and fall below it in no respect or only in unimportant respects, to come in and compete. It appears probable that two or three other companies will accept this invitation. For good or ill, competition has come to stay.

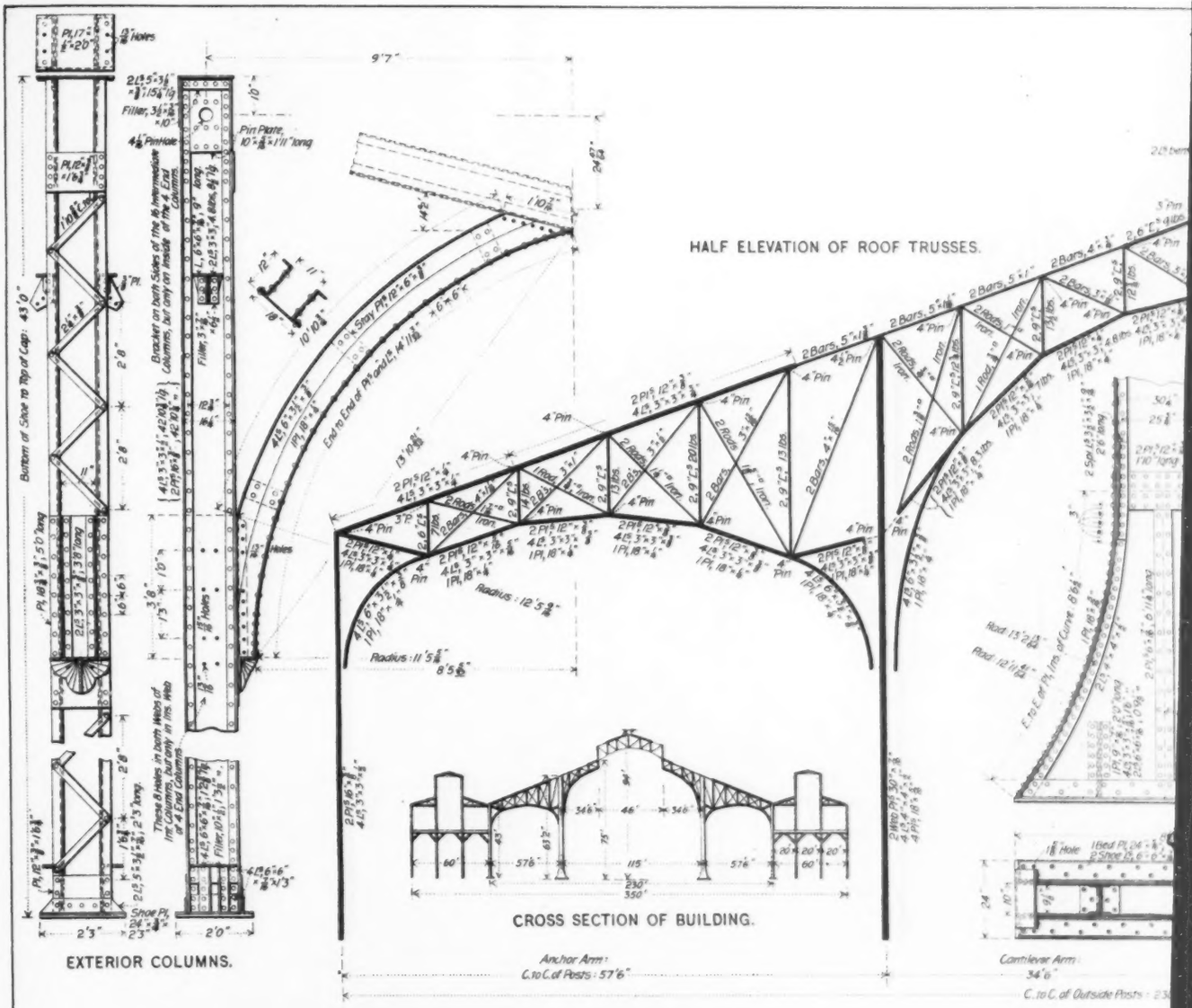
This being so, and the principle of all these brakes being the same, it is highly important that they should not only work interchangeably, but uniformly, especially in the detail which experience has shown to give most trouble, certainty of release.

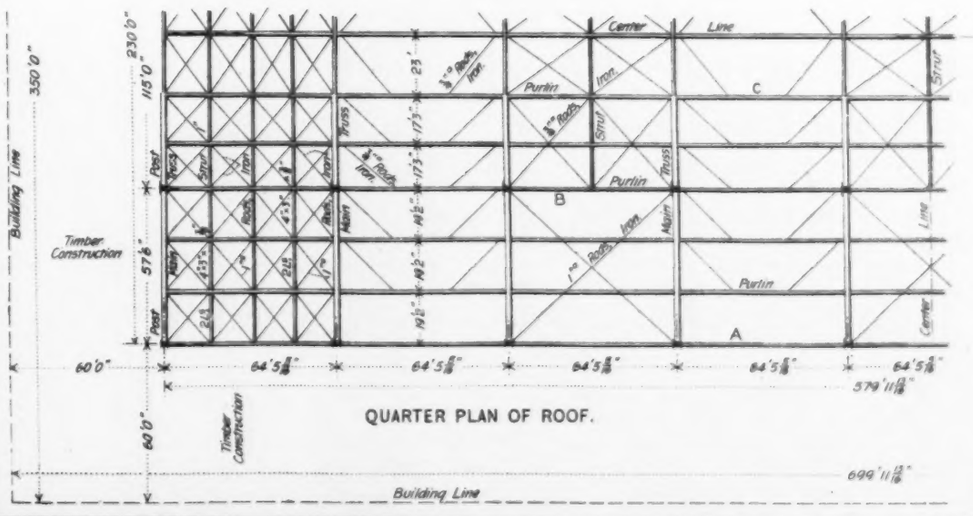
As experience shows that the Westinghouse brake will apply easily on a 50-car train in 2¾ seconds or less, and more time can only be required because the air passages are more obstructed, why should 3½ seconds or any time less than "about 2¾ seconds" be specified in Application Test (a)? We see no reason, and do not believe competing companies desire it.

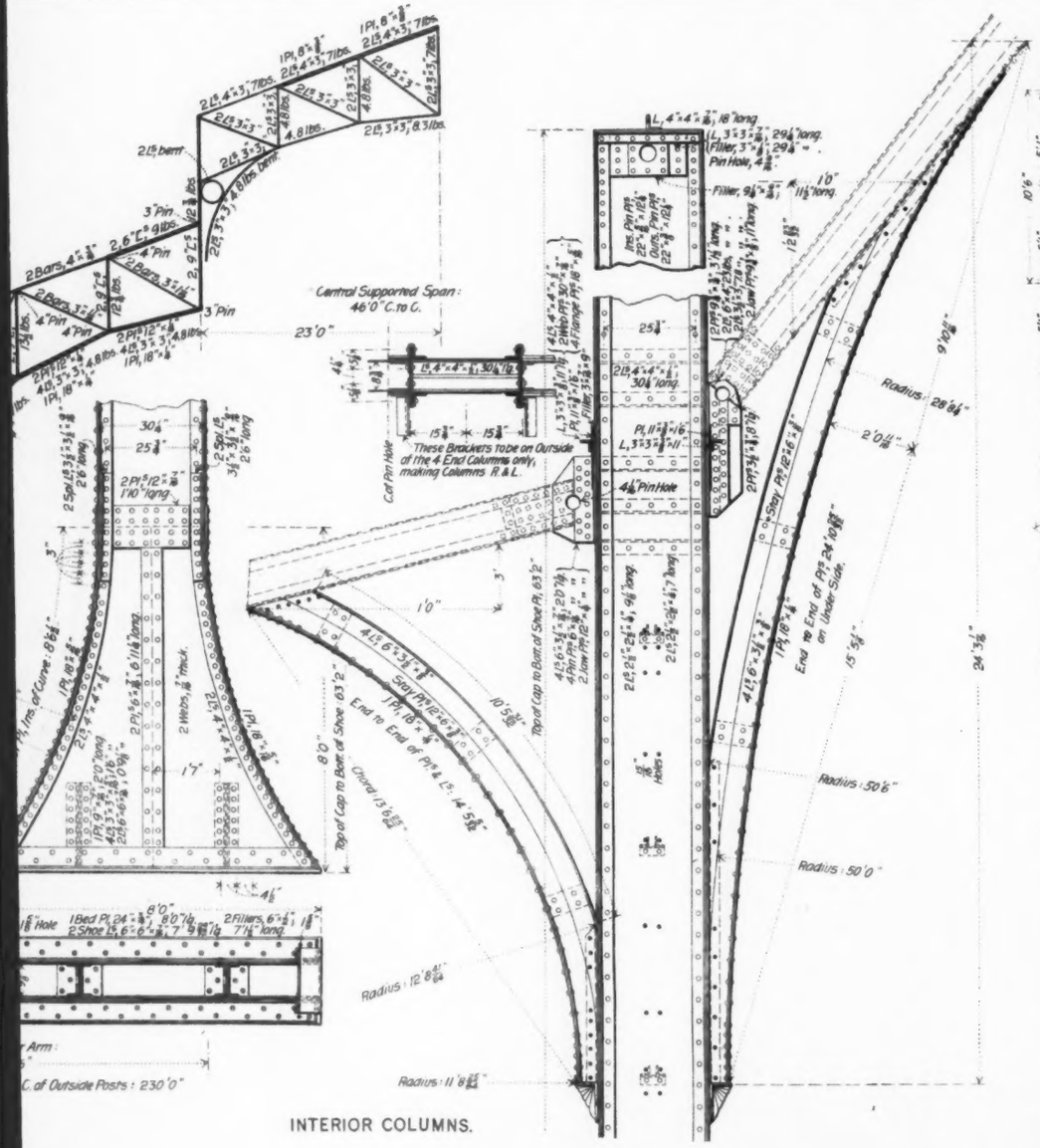
As to jumping cut-out cars, the minimum limit of three cars seems right, but as it is no more desirable to have the emergency valve too sensitive than too dull, a maximum limit of say seven cars might well be specified also, beyond which it is not desired nor desirable that cut-out cars should be jumped. Otherwise, emulation may have an unfortunate effect.

This applies still more strongly and directly to the test for the sensitiveness of the emergency valve. In the first place, it seems to us, it is desirable to determine by a very considerable number of tests of individual emergency valves, just what the necessary maximum and minimum limits are to include all well made emergency valves, as determined by the present practice of the Westinghouse Brake Co. (or any other company which thinks it can do better); and then two apertures should be distinctly specified, discharging air through one of which should certainly give an emergency application, while discharging through the other certainly should not. While it is very desirable to shut out no proper competitor, this test, it seems to us, should be rigidly held up to the highest attainable practical standard.

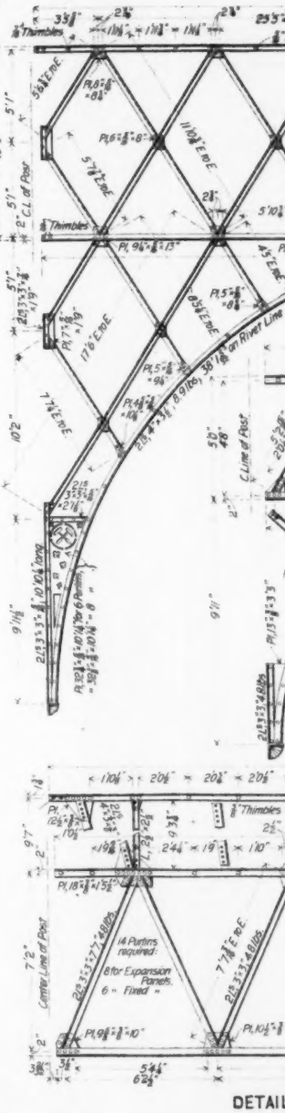
The same is still more true of the release test. The Westinghouse brake made a very remarkable record in this test last week, as shown in another column, and as success in it is chiefly, if not wholly, dependent upon fine workmanship, it seems to us that it is no real kindness to any competitor to lower the standard in any respect below the best average which any company can realize. Certainly it is no kindness to the railways who are to purchase the brakes to do so. As it is shown that the


HALF ELEVATION OF ROOF TRUSSES.
CROSS SECTION OF BUILDING.
EXTERIOR COLUMNS.
Anchor Arm:
C. to C. of Posts: 57'6"
Cantilever Arm:
34'6"

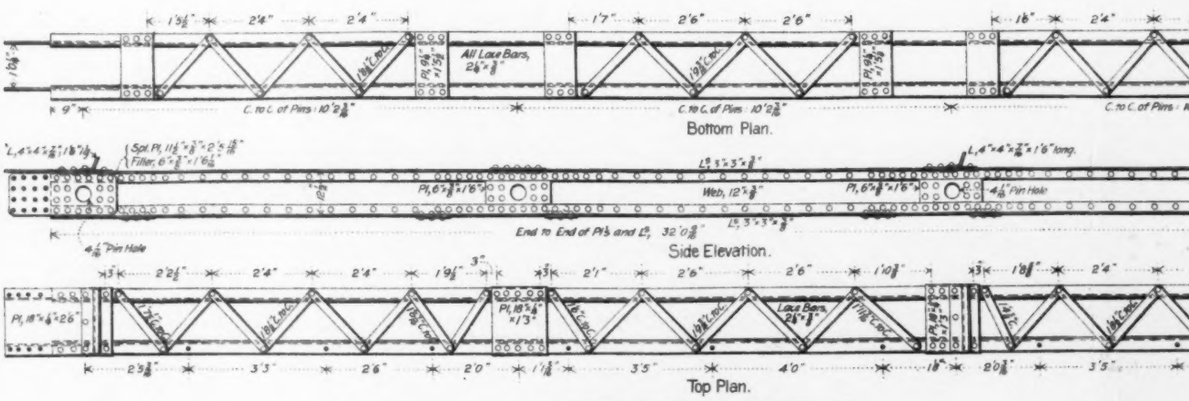

Building Line
350'0"
230'0"
115'0"
Timber Construction
576"
Post
Center Line
Purlin
Truss
Main
Strut
Iron
Rods
Timber Construction
60'0"
64'5 5/8"
579'11 1/8"
699'11 1/8"
Building Line
QUARTER PLAN OF ROOF.


Central Supported Span: 46'0" C. to C.
23'0"
These Brackets to be on Outside of the 4 End Columns only, making Columns R. & L.
Radius: 28'8¼"
Radius: 50'6"
Radius: 50'0"
Radius: 12'8⅝"
Radius: 11'8⅝"
End to End of Pins 24'10⅜"
Top of Cap to Bott. of Shoe: 63'2"
C. of Outside Posts: 230'0"

INTERIOR COLUMNS.

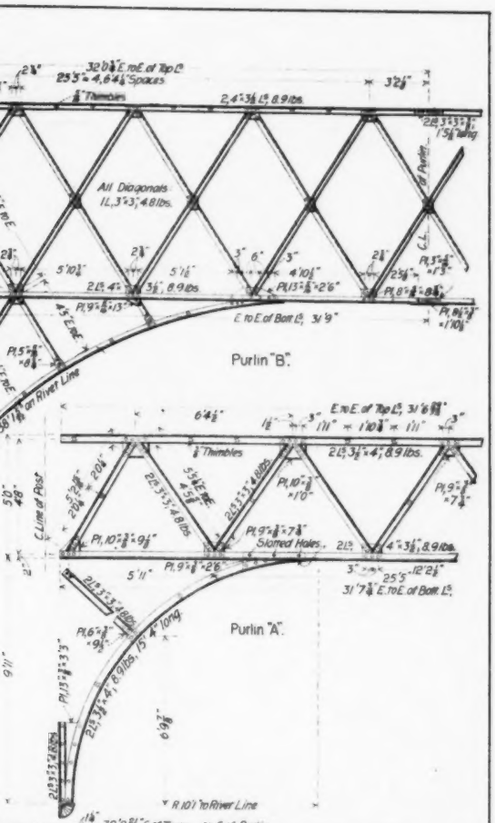


DETAIL

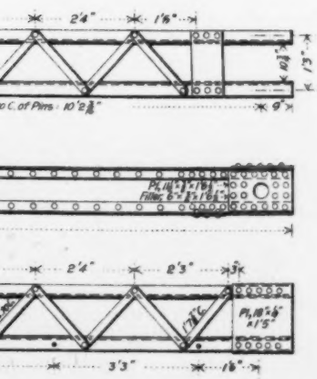


UPPER CHORD OF ANCHOR ARM.

MINING BUILDING; WORLD'S COLUMBIAN EXPOSITION.



DETAILS OF PURLINS.



CHAS. HART & SONS, LITH., 28 VESEY ST., N. Y.

air entering a 50-car rack through a 1-16-in. hole will release 46 out of 50 Westinghouse brakes, why should any company be considered a fair or desirable competitor which cannot release 35 or 40 cars at least in that way? And for rack tests, at least, letting in air through a fixed aperture is much better than supplying it directly from a pump.

The graduating test is in itself hardly so vital a matter, but as an indication of perfect design and workmanship it is almost equally important. As the Westinghouse brake will go on with 5 lbs. reduction of pressure, and make five successive increases of brake pressure with five successive reductions of 1 to 2 lbs. each before the pressures equalize, why should the requirements be limited to applying after 10 lbs. reduction, with one intermediate between that and equalization of pressure at 30 lbs. reduction? It appears to us that a much more severe test can be met by any competitor which has a reasonable hope and claim for general patronage, and therefore should be specified. It may (or may not) make a little delay in that company's reaching full and regular standing, but when it gets there it will be able to keep there.

As for the holding power test, the Westinghouse brake has evidently been designed to let a little more air leak into the brake cylinder than leaks out of it while the brakes are on, so that, if anything, the brake pressure shall rise during a prolonged service application, and the average be maintained in spite of a few leaky pistons. So far as we know, no one expected that the brake would do as well as it did in this respect; but it having been shown to be possible, it is an advantage hardly to be ignored. It appears to us that it would be reasonable to specify that, after a light service application, the pressure should not leak on so fast as to equalize with the auxiliary reservoir in less than 10 minutes, on the one hand; nor leak off so fast that any cylinder should show a reduction of pressure in less than 30 minutes, on the other hand. We suggest these particular limits with diffidence, but that they are right in principle and in substance seems clear.

The proper time for charging one empty auxiliary reservoir, with the train pipe at 90 lbs. pressure, is admitted to be not less than 45 nor more than 60 seconds. Therefore, with all these tests defined within limits, in substance as outlined, we do not see why a purchaser of any brake which successfully passed them could not do so with a sufficient assurance that it was not only "practically as good," but functionally identical with the Westinghouse brake; unless in the one respect of durability, which long service only can determine. Surely it is better for any competing company to stand on this high plane than to have the standard lowered in the slightest for its benefit. When the time comes, if it ever does, when any company shall say: "Here, we can do this much, which it is practically sufficient, but we can't quite meet your schedule" in this and that respect, then it may be time to lower the bars a little, but to lower them in the beginning is to endanger the interests of all.

We have so far spoken only of the brakes themselves, because they only are referred to in the proposed schedule of tests; but it would seem as if some further stipulations in regard to the engineer's brake valve were also essential. It would seem as if, in every proper engineer's valve, there should be certain fixed positions of the handle within which (and for a certain distance beyond which toward the emergency notch) it should not be possible to cause an emergency application by any handling of the valve; in other words, it should in all cases be the position, and not the way of moving the valve handle, which determines whether an emergency or service application follows. We may be wrong, but we understand there are engineers' valves upon the market which do not meet this requirement. They should be reconstructed to do so.

The coupler situation is much less favorable. It is not nearly so well known just what ought to be demanded; there is a greater number of competitors; their average skill and responsibility is less. At last week's meeting in Pittsburg a nominal set of standard specifications was adopted, but the difficulty is that it is not yet known precisely what tests can reasonably be imposed, nor (what is still more important) what tests the couplers already on the market will stand.

The very first step, therefore, for correctly determining what can be done is to show what has been done, by actual test of a sufficient number of each of the prominent makes now on the market. There are nearly a dozen of these, all told, not counting the "wild cats" which have not passed the embryo stage. The greatest light which has been shed on the question so far was the paper by Mr. Wm. Forsyth, Mech. Engr., C., B. & Q. R. R., published in our issue of March 5. Mr. Forsyth there gives the records of a few tests, showing that six malleable iron couplers varied in tensile strength from 80,000 to 121,000 lbs., averaging less than 100,000 lbs., while as many cast steel couplers varied between 98,200 and 148,800 lbs., averaging 116,300 lbs. He draws the conclusion that couplers should be required to show a tensile strength of 125,000, and this is what was adopted at Pittsburg, after a good deal of "daring" back and forth between the manufacturers, though the committee itself had only proposed (more wisely, we are disposed to think) 100,000 or a possible 110,000.

As for the drop test, out of 11 recorded tests of malleable couplers with wrought iron knuckles, only one stood the proposed test (3 drops of 10 ft., 2 of 15 ft., with a 1,640-lb. drop), two stood only one 15-ft. drop, three failed at the third 10-ft. drop, three at the second, and one at the first. The cast steel couplers showed up even worse. Out of three recorded tests, one failed at the first 10-ft. blow, one at the second, and one at the second 11-ft. blow.

We are aware that Mr. Forsyth might have submitted a considerably greater list of tests of this kind than he gives in his paper. Nevertheless, the present basis of knowledge as to just what the couplers now in use will stand is far too limited to enable any one to say with certainty what can reasonably be demanded. Moreover, as we intimated in our last issue, it is not certain that the basis of the tests themselves is right. A small weight falling through a great distance and a great weight falling through a small distance, though striking the same blow in foot-pounds, have a very different fracturing effect and require quite different physical qualities to best resist the blow.

In all testing the aim should be to imitate as accurately as possible the precise nature of the rupturing strains in service. Now, we are of opinion that a weight of 1,640 lbs. striking a coupler a dead blow at a given velocity will try its metal at least as much as the blow from a whole train of cars will do in service, eased as it is by a pair of springs on every car. If so, it is not wise to use so high a fall as to give an impact velocity much greater than occurs in ordinary coupling work, which we may take as 4 to 6 miles per hour; and using this lower drop would have the further advantage of requiring a greater number of blows to cause fracture, and thus indicating finer gradations of strength. We earnestly commend this suggestion to the attention of the committee, not as certainly sound, but as possibly leading to important differences of results, and hence deserving of test at least. The impact velocity of a weight falling

3ft., 4ft., 5ft., 6ft., 8ft., 10ft., 15ft.,

is in miles per hour about

9.0, 10.3, 11.5, 12.6, 14.5, 16.4, 20.5.

It appears to us that the proper standard of drop is the lowest one, which, on an average, will cause fracture within a reasonable number of blows, say 20. Whether a 5-ft. fall will do this or not we cannot say, but if not, such higher fall as will suffice to do it should be adopted tentatively, and no higher, until it is shown that the higher fall gives corresponding results more quickly.

There is another aspect of the proposed schedule which deserves consideration. Is it not true that at least 100 couplers fail by fracture under impact (including impact blows due to emergency application of brakes) to one which fails under tensile strain? We so understand it; and if so, it would seem to be bad mechanics to dwell much on tensile strength in a testing machine, or to establish so high a tensile standard as to exclude couplers for this cause which could pass the impact tests. In testing say ten couplers we should greatly prefer to break eight under impact and only two by tension, rather than to break one of each pair by tension.

Another defect of the proposed schedule is that it provides no guard arm tests, though statistics show that something like two-thirds of all the coupler body fractures now occur in the guard arm. It would be one of the advantages of a lower drop that it would provide a natural method of testing the guard arm also.

But the main desideratum at present is to determine just what the couplers now in service will stand, by a very considerable series of tests, say the breakage of 6 to 10 couplers of each make now on the market. If the committee will undertake to make such tests, the railways having the several couplers in use will beyond doubt gladly furnish a set for tests from their service stock, besides which the different manufacturers might be asked to furnish a special set, embodying their latest improvements. As with the brake tests, which did so much good by directing the strong and saving the weak from further loss, all the results of these tests should be at once made public. No man has any trade rights which deserve respect under the existing status, other than to have the whole truth told about his product. No one could be really injured by such a test, and no one could fail to be benefited, whether he continued in the coupler business or concluded to step down and out. If he continues, he continues on right lines, at the cost of a little temporary mortification at worst. If he steps down and out he only does so a little sooner and with a little less loss than if he hoped against hope for a year or two more, working in the dark. "An examination of facts is the foundation of science." It is also the only possible foundation of a rational and adequate set of standard coupler tests.

THE GREAT LAKES AND HUDSON RIVER SHIP CANAL.

The proposal to rebuild the Erie Canal and make it available for vessels drawing 18 ft. of water or more is again brought forward by Mr. E. P. North, M. Am. Soc. C. E., in this month's "Forum." He presents anew the impressive statistics of the growth of commerce on the great lakes to show the probable usefulness of the enterprise. The aggregate tonnage entering and clearing from the ports of London and Liverpool in a year does not equal that passing Detroit in seven months. The freight traffic on the lakes in 1890 amounted to over 17,000,000,000 ton miles, equal to almost one-fourth the total freight traffic on United States railways. Average freight charges on the lakes were 0.13 ct. per ton mile in 1890; and the average freight charges on all railways of the United States, according to the Interstate commerce statistics, were 0.922 ct. per ton mile. On this basis Mr. North computes that the value of the lakes as a traffic route is measured by a saving in a single year equal to (0.922—0.13 ct.=) 0.792 ct., multiplied by the total traffic in ton miles =nearly $136,000,000.

But without impeaching the intended deduction that an immense traffic would await the successful completion of a practicable ship canal between the great lakes and the Hudson, it is apparent on a little examination that this method of computing the money value of the great lakes as a traffic route is very inaccurate and quite misleading. The average railway freight rate per ton per mile for the whole United States is at least twice, and possibly three, times as high as the average rate on the grain, coal, ore and other bulk freights which make up most of the lake shipments. Moreover, the average freight rate on through traffic between Chicago and Buffalo or the seaboard is much below the figure given above. The average freight rate in the states of Ohio, Indiana and Michigan is only 0.695 ct. per ton mile, according to the Interstate Commerce Commission's statistics. The average freight earnings per ton mile on the middle division of the Philadelphia & Erie R. R. in 1889 were 0.485 ct. The same figures for the New York Central & Hudson River in 1891 were 0.76 ct.

From figures easily accessible to any writer, however, we may make a still closer approximation to what is a reasonable estimate of the gain from a ship canal. The ruling rate on flour in recent years has been 20 cts. per bbl. from Chicago to Buffalo by lake (steam vessel), and only 20 cts. more to carry it on by rail to New York. On bulk grains the difference is more, but still nothing like what the figures given by Mr. North would indicate. Fair average figures for bulk grain in recent years have

been 2½ cts. per bu. of 56 to 60 lbs. by lake to Buffalo, and 6 cts. more, or 8½ cts. in all, to carry the grain on by rail to New York. This is only in the season of navigation, of course, but that is all we need to consider. By Erie Canal the rates are not much lower; they will average fully 4 cts. Converted into cents per ton mile, and using for distances those of the leading line, the New York Central & Hudson River,, and taking 35 bushels to the ton, they compare about as follows:

Flour:	Per ton.	Per ton mile.
By lake steamer, Ch'go to Buff., 500 m.	$4.00	0.74c.
" rail, Buffalo to N. Y., 440 m.	4.00	0.91c.
Grain (mean of wheat and corn:		
By lake steamers, Chicago to Buffalo...	0.875	0.16c.
" rail, Buffalo to N. Y.	2.10	0.48c.
" Erie Canal, Buffalo to N. Y.	1.40	0.32c.

It will be seen that the difference between lake rates and canal rates is only 1-6 ct. per ton mile. If the lake route were as direct as the rail, or if we had used the lake distance instead of the rail distance as a divisor, lake and rail would compare better; but the extra cost of transit in a ship canal over the open lake is at least as great as the added expense from the extra lake distance around the peninsula of Michigan, for which we have not allowed mileage. Therefore, this 1-6 ct. per ton mile measures about the extent of the possible saving from a good ship canal paralleling a railway.

These figures are sufficient to show that Mr. North greatly exaggerates the money value of the lakes as a transportation route. The error is an important one, because he uses the figures above given to make a rough estimate of the value of a deep waterway between Buffalo and New York City. He makes a proportion as follows: Average haul of present lake traffic (566 miles) is to distance from Buffalo to New York (495 miles) as the annual saving in transportation charges on present lake traffic ($136,000,000) is to annual saving in transportation charges by proposed Buffalo-New York waterway ($118,700,000).

From this vast sum Mr. North makes great deductions on account of the reduction in speed in the canal and its more or less limited capacity. For instance, with an annual traffic of only 10,000,000 tons and with average speeds of 5 and 2½ miles per hour, he finds that the annual gain from the canal would be $15,600,000 and $7,800,000 respectively. As these figures, like those above, are based on an exaggerated estimate of actual railway rates on long distance bulk traffic, they also would have to be greatly reduced to arrive at the real truth.

It should be added that the proportion above given is not claimed by the author to be strictly correct. He merely offers it as a method of gaining an approximate idea of the saving in transportation charges which the canal would effect. But we have shown that it is not even approximate, and gives no true idea of the real gain.

We hope (and certainly are not prepared to deny) that nevertheless the construction of such a ship canal is justified and demanded; but in one other respect Mr. North's argument seems a little weak. He claims that the reduction of freight rates on American railways during the past quarter century is due to water competition or to the protective tariff, and hints that both causes have been operative. Comparing English and American freight rates, he declares that the former have remained practically stationary during nearly all the time since free trade was adopted in that country and since canal improvement ceased.

It may certainly be conceded that the high freight rates on English railways are due in part to heavy capitalization, lack of competition, and perhaps to uneconomical methods and machinery; but every careful student of railway economics will agree that the chief reason for the contrast between English and American freight rates (apart from the great item of water competition on a scale quite without precedent) is the short haul and high class of goods shipped in England and the very long haul and large proportion of bulk freight which characterizes American railway traffic, and which could not be hauled at all except at very low rates. The proportion of terminal expenses to the total cost of moving freight increases largely with the density of population. At a recent annual meeting of the Pennsylvania R. R. President Roberts remarked: "Every ton of merchandise secured in Philadelphia to be transported westward has to be hauled 70 miles before the revenue received therefrom equals the actual cost of handling in Philadelphia."

Again, in New England, more than in any other section of the country, the conditions under which railways are operated resemble those in Great Britain. And in New England we find higher average freight rates than in any other part of the country except the Pacific coast. They are still far below the British rates, but had New England been an isolated island we may be very sure that freight rates would never have fallen there to anywhere near their present figure.

Returning to Mr. North's arguments in favor of the canal, some interesting figures are presented concerning the vessels on the lakes. Their value for insurance purposes is no less than $60,000,000, and the fleet includes 126 vessels which register over 1,500 net tons. Of these, 89 are built of steel, and 32 additional steel vessels are under construction. Were a waterway open by which these vessels could pass to the ocean, Mr. North claims with good reason that they would participate in the ocean-carrying trade during the five months of the year when the lakes are closed to navigation, and would reduce ocean freight rates by their competition at a time when the exports are heaviest. Some of these freight carriers in their regular trips between Chicago and Buffalo make better time than is made by the heavily subsidized mail steamships of the Peninsular & Oriental Co., plying between England and Indian Ocean ports.

As to the alleged "military advantages" accruing from such a canal, we see no reason why we need any, but for commercial reasons only we agree with Mr. North that if any waterway from the lake to the sea is to be opened by government aid it should lie wholly in our own territory. He gives no estimate of the cost of an Erie Ship Canal, but it was set by Mr. Elnathan Sweet in his paper on "The Radical Enlargement of the Erie Canal" (a) at $125,000,000 to $150,000,000. This estimate was for a waterway 18 ft. deep and 100 ft. wide at bottom, with locks 450x60 ft. At present, however, Mr. North himself says that neither a marked increase in tonnage on the lakes nor a decrease in freight charges can be expected until a minimum depth of 20 ft. from Buffalo to Chicago is provided. The proposed canal would need, therefore, to have at least 21 or 22 ft. depth, which would make a large increase in its cost over the above figures. Still with careful location and design it might be built, possibly, for much less than $200,000,000, and it ought to be worth to the people more than that sum, though it would hardly be worth that as a commercial enterprise. We have criticised the author's method of computing the economy of water transportation over the railway, because such overestimate of railway freight rates does not really strengthen, but weakens, the arguments of canal advocates. Nevertheless, it seems to us that the enormous growth in the volume of the traffic between the Mississippi Valley and the seaboard already demands careful study of the possibility of a ship canal between them. If not too costly, it would pay, even though the traffic by railway which the canal would displace be estimated at its minimum cost.

Ties in stacks ready for use are preserved from decay in a singular manner in one part of India, according to "Indian Engineering." The ties are of sal wood, and are stacked lengthways and crossways alternately in stacks of 100 ties each. These stacks are covered outside by a plaster of clay and grass, which forms a weatherproof covering and protects the ties from decay. It is said they are "hermetically sealed," but as this would be difficult to effect, and would probably cause rot to start from the natural moisture of the wood, a weatherproof covering is probably all that is aimed at.

The nickel deposits of North Carolina are treated of in a paper by Mr. S. H. Emmens, in the "Engineering and Mining Journal." He summarizes the present position of the nickel industry in that State as follows: First, there does not exist any deposit of proved value; Second, the chrysolitic rocks in the neighborhood of Webster, N. C., are undoubtedly nickelliferous in a commercial sense of the term; Third, it is probable that judicious exploration will open up deposits of limited extent, but capable of being profitably worked for some years.

(a) Trans. Am. Soc. C. C., Vol. XIV., p. 37.

LETTERS TO THE EDITOR.

CEMENT JOINTS FOR WATER MAINS.

Sir: Can you give me any information in regard to cement joints for cast iron water mains in lieu of lead joints?

A. F. Harley, City Engineer.

Jacksonville, Fla., April 27, 1892.

(Such use of cement in place of lead is rare, but we are reliably informed that it was once used on a pipe line for a mill or factory water supply, and although the pressure was slight there was much trouble from leakage. If any of our readers can give instances of the successful use of cement in this way we should be pleased to have them do so, but we do not think it likely that they can.—Ed.)

SPECIFICATIONS FOR PIPE LAYING.

Sir: The specifications for pipe laying for this place read: "Lay pipes on north and east side of streets 2 ft. below grade line where established," etc. It is held that this means that the top of the pipe shall be 2 ft. below grade. What is the practice? The largest pipe is only 8 ins. in diameter. Subscriber.

Atalla, Ala., April 23, 1892.

(The practice is, or should be, to specify whether top or bottom of the pipe is meant. In case this important point is not specified the top of the pipe would be understood.)

THE KAW RIVER BRIDGE, KANSAS CITY.

Sir: In your issue of April 21 there was a letter from Mr. Benjamin F. LaRue concerning a level truss bridge with inclined floor built over the Kaw River at Kansas City. Mr. LaRue gives me credit for the design, and as it is not due me I write to make a correction. The design was made by the Kansas City Bridge & Iron Co., and their papers were submitted to me by the Chief Engineer, the late Wm. B. Knight, for checking and correcting. I made a number of corrections and suggestions, some of which were accepted and some of which were not.

Very respectfully yours, J. A. Waddell.

Kansas City, Mo., April 28, 1892.

EFFECT OF DAMS ON RIVER CHANNELS.

Sir: Will you please give me the name of some book that you regard as an authority on the effect of dams in the channel of rivers? There is a dam 8 ft. high in the Neosho River. The river overflows quite often and we wish to determine, if possible, what effect this dam has on the height of the water. Yours respectfully,

Frank H. Greene, Co. Surveyor.

Erie, Kan., April 19, 1892.

(Our correspondent refers undoubtedly to the backwater problem, a question which, under the simplest assumptions, can be solved theoretically, but for which in most practical cases only approximate solutions are possible. We know no book that can be called an authority on this difficult subject, but we refer to Merriman's "Treatise on Hydraulics" for a discussion of it, together with a table of the "backwater function" and several numerical examples fully worked out. A most interesting popular presentation of this problem, by the way, may be found in a book of 91 pages, published in New York in 1849, entitled "Letters on Hydraulics; a Correspondence Between E. S. Chesbrough, of Massachusetts, and C. F. Durant, of New Jersey, on the Physical Laws That Govern Running Water, Applied to a Dam and Mill Privilege on the Housatonic River." This book has been long out of print, and is indeed so rare that we have seen but one copy of it.—Ed.)

AN END ADJUSTING GEAR FOR DRAWBRIDGES.

Sir: I notice in your issue of April 16 an idea for a draw span which is very similar to one which I proposed at Edge Moor three years ago. My scheme differed somewhat in the details, however, and I think it is rather the simpler of the two. Fig. 1 shows the general arrangement. The bars (AC) and (BC) have the pin holes at (C) somewhat elongated, so that when the span is closed, and the bars are on a level, they will be perfectly loose on pin (C). The first action of the operating machinery, which may be wholly automatic, would be to pull down on the rod (CD). The spans would turn on the pins (E) and (F), and the ends would be raised clear from the masonry. Only a small force would be needed on (CD). Since the two spans would never exactly balance, it would be necessary to provide for forcing the pin (C) to go down vertically, to insure lifting both spans. To do this my idea was to use two light posts, taking the main pins (E) and (F) at the bottom and coming together at (C) at the top, somewhat like Figs. 2 and 3. The pin (C) moving in the slot between the two girder angles of the posts is forced to travel vertically. The rod (CD) might very well be actuated by an eccentric on a shaft at any convenient level. It would, perhaps, be preferable to re-

place the rod (CD) with a stiff member capable of supporting the weight of the bars (AC) and (CD) when the span is closed. At the ends of the spans I proposed to have a V-shaped notch cut in the masonry and shod with iron, as in Fig. 4, and a similar V on the end beams. In closing, the span being brought nearly into line, the Vs will guide it to place as it is lowered. The V in the masonry might be left open at the bottom instead of as sketched, to allow sand, etc., to drop through. The only objection I have ever heard made to the scheme was that there would be a considerable bending movement on the end post in raising the span, due to the friction on the pin at the bottom. But this amounts to nothing practically. I hope to see some criticisms of the idea now. It has never been

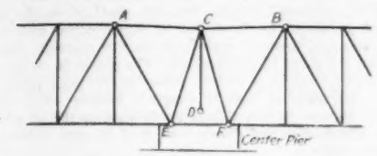
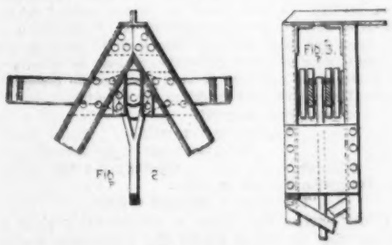
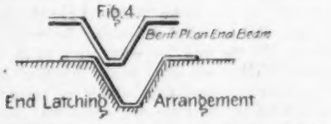


Fig. 1.





END ADJUSTING GEAR FOR DRAWBRIDGES.

used so far as I know, yet it is so obvious that it must have occurred to many, and I suspect that there may be objections which have not occurred to me.

M. J. Patterson.

Denver, Colo., April 22.

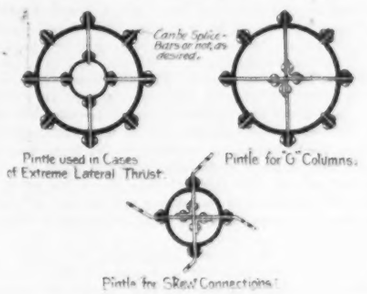
Z-BARS AND PHOENIX COLUMNS.

Sir: Owing to press of business matters I have been unable to answer Mr. Purdy's article in your issue of March 12, in which he takes some exceptions to the statements made in my letter of Jan. 9. He begins by stating that it is an open question whether Phoenix or Z-bar columns or some other column section will carry the greatest concentric load per square inch, the length of shaft and weight of metal being fixed. I understand, of course, that he means that the greatest diameter or dimension of the column shall be the same.

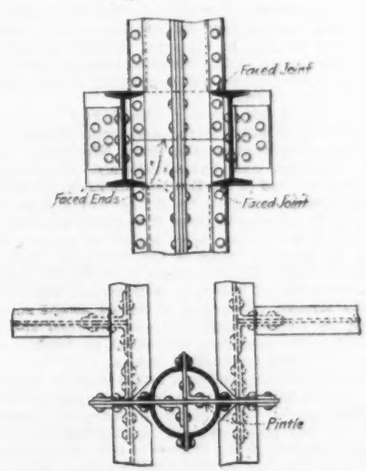
In answer to this I would state that I think it is proved beyond any question of a doubt that Phoenix columns are the strongest, and I think he will find that any engineer will concede this point. Extensive tests have been made on Phoenix columns, notably those by the Watertown arsenal, in connection with other columns which, as far as relative strength is concerned, are equally as good as the Z-bar column. This test conclusively showed that Phoenix columns were much superior as regards strength. Z-bars have not been tested very much, but they have been tested sufficiently to show that they are not as strong as the Phoenix column. Mr. Purdy admits that the relative strength of the Z-bar column is not definitely known. I should think this an excellent reason for not advocating it, as Mr. Purdy has seen fit to do. A great many engineers in this country allow a greater unit strain for the Phoenix column than for columns of other sections; but suppose that we use the same empirical factors in the formula and take columns of the same relative area of cross section and whose greatest dimension shall be constant, the radius of gyration alone will make a difference in favor of the Phoenix column. Of course, this would not be so great as if the empirical factors which represent the peculiarities of the construction of the Phoenix column are introduced in the comparison.

In relation to the building in Chicago in which the Z-bar columns were rejected, I would state that these columns were not furnished through my firm. The particulars were given to me voluntarily and quite casually by the architect of the building. As they were manufactured by one of our chief competitors in business, I do not feel justified in publishing names.

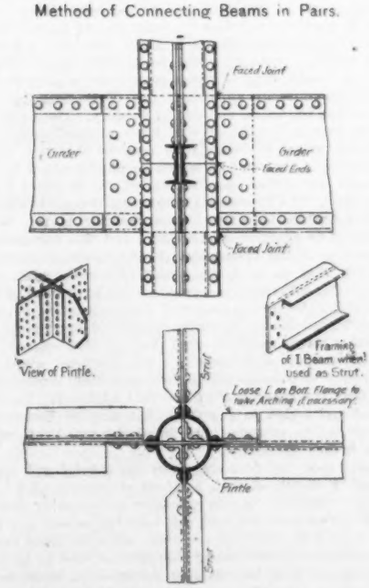
I may also call Mr. Purdy's attention to the fact that a corner of a building in Chicago gave way from the buckling of a Z-bar column, and the corner of the building would have fallen had not a cast iron column a short distance behind it held the work in place until the Z-bar column could be strengthened. I do not from personal inquiry know whether the column had more load on it than it was intended or designed to carry, though I am informed it had not; but in any event


Can be Splice-Bars or not, as desired.
Pintle used in Cases of Extreme Lateral Thrust.
Pintle for "G" Columns.
Pintle for Shop Connections.

Arrangements of Pintles.



Method of Connecting Beams in Pairs.



Method of Connecting Girders and Struts.

PHŒNIX COLUMNS, CROSS PINTLE CONNECTIONS.

this goes to show what I tried to prove in my previous correspondence, and that is, that it is not safe to figure too near the limit, as is done in Chicago and the West generally.

In relation to the eccentric loading of which Mr. Purdy speaks, I think he will find that the majority of columns are nearly all loaded with concentric loads, and it is an exception to find columns with very great eccentric loads. I will admit for the sake of argument that it would be necessary to make some part of the Phoenix column heavier than the balance. I do not know what there is more simple than to roll either one or more of the segments heavier than the rest. With the pintle connection, of which I have spoken in my last article, I think that the load can be fully distributed. The pintle acts as a continuous web and transmits the strain, not only to the opposite side of the column, but to as many other points as may be desired. I cannot see how the load can be more centrally applied.

I give herewith two sketches (plates 25 and 26, from "Phoenix Column Construction," published by Milliken Bros.) showing more fully how this is done. This arrangement gives a continuous column from the cellar to the roof, in which the joint is the stiffest point, both vertically and laterally, of the whole column. No brackets occur to interfere with either floor or ceiling finish.

Recently I had a conversation with one of the largest concerns manufacturing Z-bar columns, and they assured me that they have constant trouble with the twisting and winding of Z-bars before and after riveting up. I should gladly recommend the use of Z-bar columns if I could feel that they were in any way equal to the Phoenix columns, as the mill which I represent makes both Z-bars and Phoenix columns. I therefore feel that I am in an unbiased position to state what I really think is the best form of column.

Mr. Deforth's article in your paper of Jan. 30 has also been called to my attention. The column which he suggests, made out of channels and Phoenix column segments, has been made for some time. Some I know were made for a building in San Francisco several years ago. The bracket suggested by him for eight-segment G-columns I would criticise in that if it is desired to carry a greater load than 30,000 lbs. it should be made in a different manner. He can hardly expect a column to be designed to take the load that would come on one bracket, for if this was the case, there would be no bracket; the load would naturally rest directly on the top of the column. If Mr. Deforth will carefully read my letter, he will note that I recommend what I think is superior to that form of connection, and that is, a pintle or through gusset plate, to which bracket connections can be made.

New York, April 27, 1892. Foster Milliken.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

VIII.

(These papers will be republished in book form, and corrections or proper additions are solicited, and can be made at any time.)

THE LAWRENCE SCIENTIFIC SCHOOL.

The Lawrence Scientific School, the third engineering school founded in order of time, but for some twenty years after its foundation the only one founded with any promise of strength except the Rensselaer Institute, was founded in 1846, as already stated, in anticipation of a gift of $50,000 from the Hon. Abbott Lawrence which followed next year. This to-day seems a small sum, but half a century ago it was a large sum, and in fact is officially stated in the resolutions accepting the gift, as given below, to have been "rarely, if ever, equaled in magnitude." Without counting the second gift of an equal sum which followed next year, it was undoubtedly a much larger sum than that given by Stephen Van Rensselaer to found the school named after him, though, as that gift consisted largely of land and buildings, direct comparison is difficult.

The "deed of gift," as one may fairly call the letter in which Mr. Lawrence announced his purpose and explained its aims, is reprinted in full below. It is in many respects a very remarkable document, considering its date, when the engineering arts and sciences were just beginning to arise into the prominence which they enjoy to-day, and when men in general had not yet recognized that they were to stand on a very different plane from blacksmithing and other handicrafts and trades, and demand for their successful practice a professional training as thorough as that for any other profession, if different in its nature. Mr. Lawrence explains in the clearest possible language his purpose in founding the school; outlines the conditions for the success of such a school in words which, even now, describe what should be rather than what is, for his stated conditions have never yet been fully met; and makes in effect a labored effort to correct the mental perspective of the educators of his day, by inducing them to look upon instruction in the modern forms of applied science as deserving of a prominent place

in schemes for "liberal education." His letter was as follows:

DONATION TO HARVARD UNIVERSITY.

Correspondence Between Hon. Abbott Lawrence and Hon. Samuel A. Eliot.

Boston, June 7, 1847.

My Dear Sir: I have more than once conversed with you upon the subject of establishing a school for the purpose of teaching the practical sciences, in this city or neighborhood, and was gratified when I learned from you that the government of Harvard University had determined to establish such a school in Cambridge, and that a Professor had been appointed who is eminent in the science of Chemistry, and who is to be supported on the foundation created by the munificence of the late Count Rumford.

For several years I have seen and felt the pressing want in our community (and in fact in the whole country), of an increased number of men educated in the practical sciences. Elementary education appears to be well provided for in Massachusetts. There is, however, a deficiency in the means for higher education in certain branches of knowledge. For an early classical education we have our schools and colleges. From thence the special schools of Theology, Law, Medicine and Surgery receive the young men destined to those professions; and those who look to commerce as their employment pass to the counting house or the ocean. But where can we send those who intend to devote themselves to the practical applications of science? How educate our Engineers, our Miners, Machinists and Mechanics? Our country abounds in men of action. Hard hands are ready to work upon our hard materials; and where shall sagacious heads be taught to direct those hands?

Inventive men laboriously reinvent what has been produced before. Ignorant men fight against the laws of nature with a vain energy, and purchase their experience at great cost. Why should not all these start where their predecessors ended, and not where they began? Education can enable them to do so. The application of science to the useful arts has changed, in the last half century, the condition and relations of the world. It seems to me that we have been somewhat neglectful in the cultivation and encouragement of the scientific portion of our national economy.

Our country is rapidly increasing in population and wealth, and is probably destined in another quarter of a century to contain nearly as many inhabitants as now exist in France and England together.

We have already in the United States a large body of young men who have received a classical education, many of whom find it difficult to obtain a livelihood in what are termed the learned professions. I believe the time has arrived when we should make an effort to diversify the occupations of our people, and develop more fully their strong mental and physical resources, throughout the Union. We have, perhaps, stronger motives in New England than in any other part of our country to encourage scientific pursuits, from the fact that we must hereafter look for our main support to the pursuit of commerce, manufactures, and the mechanic arts; to which it becomes our duty, in my humble judgment, to make all the appliances of science within our power. We inherit, and are forced to cultivate a sterile soil; and what nature has denied, should be as far as possible supplied by art. We must make better farmers, through the application of chemical and agricultural science.

We need then a school, not for boys, but for young men whose early education is completed, either in college or elsewhere, and who intend to enter upon an active life as engineers or chemists, or, in general, as men of science, applying their attainments to practical purposes; where they may learn what has been done at other times and in other countries; and may acquire habits of investigation and reflection, with an aptitude for observing and describing.

I have thought that the three great practical branches to which a scientific education is to be applied amongst us are, 1st, Engineering; 2d, Mining, in its extended sense, including metallurgy; 3d, the invention and manufacture of machinery. These must be deemed kindred branches, starting from the same point, depending in many respects on the same principles, and gradually diverging to their more special applications. Mathematics, especially in their application to the construction and combination of machinery, and chemistry, the foundation of knowledge and an all important study for the mining Engineer, and the key to the processes by which the rude ore becomes the tenacious and ductile metal, Geology, Mineralogy, and the other sciences, investigating the properties and uses of materials employed in the arts, Carpentry, Masonry, Architecture and Drawing, are all studies which should be pursued to a greater or less extent in one or all of these principal divisions.

To establish such a school as I have endeavored to describe in connection with the University, and under the care and general guidance of its Government, requires buildings with suitable Lecture Rooms and Philosophical Apparatus, with models and plans, and a place for their deposit and safe keeping, together with a Cabinet where every description of wood, ores, metals, &c., &c., may be deposited for the use of the students. Without the above appliances the Professors would be workmen without tools. The University has already appointed Mr. Horsford, Rumford Professor, who proposes to give instruction upon an enlarged plan in the science of Chemistry. I have often heard Professor Horsford spoken of in terms of high commendation, and as in all respects competent to take charge of this important department of science, and to bring out the most favorable results. The testimony rendered at home to Mr. Horsford's capacity has been very agreeable to me, and had satisfied me that the selection made by the Government of the College was fortunate; but I have lately learned in addition to the high character given him by his friends here, that the great practical chemist of the age (Liebig) has given his most unqualified testimony to the ability and fidelity of Professor Horsford, who was the pupil of Baron Liebig for two years.

I deem it of the highest importance, and in fact essential, that none but first rate men should occupy the Professors' Chairs in this School. Its success depends upon the characters of the Instructors. They should be men of comprehensive views, and acknowledged talents, possessing industry and integrity, each with an enthusiastic devotion to the great interests of science. They should love their profession, and work in it day by day. Such teachers will soon gather around them a large number of pupils.

To carry out this course of education in its practical branches, there should be the most thorough instruction in Engineering, Geology, Chemistry, Mineralogy, Natural Philosophy, and Natural History. Chemistry is provided for, and in the last two branches, instruction might perhaps be given by the present College Professors. In addition to these, it would be necessary to obtain the services at stated periods of eminent men from the practical walks of life. The Law School is taught by distinguished Lawyers of the highest reputation. The Medical School by distinguished Physicians. In like manner, this School of Science should number among its teachers men who have practiced and are practicing the arts they are called to teach. Let theory be proved by practical results.

To defray the expenditures, means must be procured for the erection of suitable buildings (not including dwelling houses), the purchase of apparatus, furniture, &c., &c., and provision must be made for the comfortable support of the Professors and other teachers employed. For this purpose, let the student be invited freely from all quarters, at a moderate charge for tuition. Let the numbers be only limited by the size of the Lecture Rooms, and I cannot entertain a doubt that a large revenue would be derived from tuition fees. I would suggest three professors, viz.: One of Chemistry (already appointed), one of Engineering, in its various branches, and one of Geology. The support of the first is for the present time provided for. For the other two a moderate fund must be obtained, as a nucleus of a further sum which should be added to it, to make the capital equal to that of the Rumford Professorship. The Professors in this school should depend to a considerable extent upon fees; it is the best guaranty to exertion and fidelity, and the permanent prosperity of the Institution. I will therefore further suggest, that each of the above Professors shall receive, after all ordinary expenses shall have been paid, one half of the tuition fees until they amount to a sum, annually, not exceeding three thousand dollars, including their stated salaries.—And that the Government of the college pay such sums to other teachers, whether temporary or permanent, as they may deem expedient, and that the other half of the said tuition fee be reserved and added to any fund that may be hereafter contributed to establish and found the two Professorships before mentioned.

I have now, my dear sir, given you a brief and very imperfect sketch of such a school of science as I believe the condition of our extensive and growing country requires, and you will ask how the means are to be obtained to carry out the plan, when we shall soon have an appeal made to our liberality, as well as to the sense of our best interests, to contribute a large sum of money for the purpose of finishing the astronomical department so auspiciously commenced in Cambridge. This department of science has already engaged the public sympathy, and will, I doubt not, be taken up at an early day, and placed in an independent and useful position. I cherish a wish to see the observatory, the telescope, and every instrument required to prosecute the heavenly science, ready for use, and do not intend to interfere with the claims the world has upon our community to accomplish this great and important object. Nor do I mean to occupy the ground of another branch of science that will, I suppose, at a future time, present strong claims upon the public bounty. I allude to Natural History, now in charge of that accomplished naturalist, Dr. Gray. I wish to see all these branches of science prosecuted with vigor, and moving forward in perfect harmony at Cambridge.

I therefore propose to offer, through you, for the acceptance of the President and Fellows of Harvard College, the sum of fifty thousand dollars, to be appropriated as I have indicated in the foregoing remarks. The buildings, I have supposed, without having made estimates, could be erected, including an extensive laboratory, for about thirty thousand dollars. If so, there will remain the sum of twenty thousand dollars; and I suggest, that whatever sum may remain, after the erection and furnishing of the buildings, should form the basis of a fund, which, together with one-half of the tuition fees, till the amount shall yield the sum of three thousand dollars annually, shall be equally divided between the Professor of Engineering and the Professor of Geology, and be made a permanent foundation for these Professorships. The object is, to place the three Professors in this School in the same pecuniary situations. I beg to suggest, further, that the whole income of this School be devoted to the acquisition, illustration and dissemination of the practical sciences, forever.

The details, however, and conditions of this donation, may be hereafter arranged between the Corporation and myself. I now leave the whole subject in the hands of the gentlemen composing the Corporation, in the hope and faith that the plan may be adopted, and executed with as much expedition as may be consistent with economy; and that it may prove to be honorable to the University, and useful to the Country.

I pray you, dear Sir,

To believe I remain,

Most faithfully, your friend,

(Signed) ABBOTT LAWRENCE.

To Honorable Samuel A. Eliot,

Treasurer of Harvard College.

Every part of this letter is unmistakably clear as to the kind of school which Mr. Lawrence desired to found. It was to be "a school for the purpose of teaching the practical sciences," he repeatedly reiterates. There was "pressing want of an increased number of men educated in the practical sciences," or in "the practical applications of science." The school was to "educate our engineers, our miners, machinists and mechanics." He dwells with what now seems needless force, but which was then preaching a new gospel, upon the necessity of training "sagacious heads" to direct the work of horny hands; upon the over-supply of men of classical training, and under-supply of men trained to direct the "appliances of science" to "commerce, manufactures and arts." Had he chanced to know of Telford's noble definition of "that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in nature for the use and convenience of man," he would doubtless have used those same words to express the purpose of his school, as he does in paraphrase.

Not content with generalities, Mr. Lawrence proceeded to stake out specifically the course which he desired his school to follow. "The three great branches to which a scientific education is to be applied" are, "1st, engineering; 2d, mining, including metallurgy; 3d, the invention and manufacture of machinery." Mathematics, chemistry, geology, mineralogy, and other like sciences not in themselves directly practical, are to be studied "to a greater or less extent in one or all of these principal divisions," i. e., in so far as they are pertinent to the engineering courses, as adjuncts to the main objects of the school. "To carry out this course of education in its practical branches there should be the most thorough instruction in engineering, geology, chemistry, mineralogy, natural philosophy and natural history," the last two to be taught by the present college professors. Of zoology, botany, anatomy, physiology, astronomy, and other like studies which were to become dominating features of the school, there is not a word.

Then follows this sagacious suggestion, which alone makes the letter a remarkable document, as outlining the requirements for a successful scientific school:

In addition to these (the regular professors) it will be necessary to obtain the services at stated periods of eminent men from the practical work of life. The law school is taught by distinguished lawyers of the highest reputation. The medical school by distinguished physicians. In like manner, this school of science should number among its teachers, men who have practiced and are practicing the arts they are called upon to teach.

Had the Harvard authorities but listened attentively to this one bit of advice, and acted thereon, all other faults of omission or commission might have mattered little, for it is likely that the Lawrence Scientific School, in spite of other drawbacks, would be to-day the most successful engineering school in the country. Instead of acting on it, they shortly after (1849) appointed a Second Lieutenant of Engineers (Prof. Henry L. Eustis) as professor of engineering, and all the light on the practice of engineering in any department which reached the students of the school from then until his death in 1855 reached them through him, and since that date no professor of engineering has been appointed.

In this they but followed the usual practice (or what has since become such, for there was then no practice), but it is a thoroughly absurd one, and it continues to exist, in our judgment, only because instruction in engineering is so new a thing that the best methods of giving it have not been fully developed. It is still the custom to appoint some young graduate (none others can be attracted by the salary) as "professor of engineering," and rest content with that, neglecting altogether the vast improvement in the quality of the instruction which could be gained by engaging prominent engineers to deliver yearly courses of lectures on their specialties, which many of them would do for very moderate compensation, as a labor of love, if they felt it was only a part of a general system in a live institution.

Prof. Eustis, in fact, was an unusually good appointment, as such appointments go, having graduated at the head of his class in 1842 (John Newton graduating second), and had five years of actual experience in the Corps of Engineers and two years as assistant professor of engineering at West Point before he was appointed at Harvard. We would not do his memory an injustice by implying that he was responsible for the comparative failure of the school. He gave for many years the best instruction in engineering to be had in the country. That it did not bear its natural fruit in carrying forward his school to prominence was due to other causes.

In two other passages toward the close of his letter Mr. Lawrence reiterates his desire that his school should follow the specific lines laid down by him. Lest his casual reference to natural history, above quoted, might be taken as meaning too much, he says:

Nor do I mean to occupy the ground of another branch of science that will, I suppose, at a future time, present strong claims upon the public bounty. I allude to Natural History, now in charge of that accomplished naturalist, Dr. Gray.

Little could the writer then have foreseen that natural history was from the beginning to be made the leading feature of the school! Finally, at the end of the clause formally tendering his gift, Mr. Lawrence adds this injunction, two words of which we venture to put in capitals:

I beg to suggest, further, that the WHOLE income of this school be devoted to the acquisition, illustration and dissemination of the PRACTICAL sciences, forever.

Never, surely, was the nature of a proposed trust more clearly outlined, and rarely, indeed, has one been created which, from the distance of half a century, seems more timely, more wisely conceived or more sagaciously defined.

On the same day the Corporation of Harvard College held a meeting, at which the following resolution was passed, accepting this trust:

At a meeting of the Corporation of Harvard College, held in Boston, June 7, 1847:

Voted, That the Corporation receive with satisfaction mingled with admiration, the gift this day presented to Harvard College by the Honorable Abbott Lawrence,—a donation rarely, if ever, equaled in magnitude, and unsurpassed for the utility of the object to which it is devoted.

It is not only in accordance with the munificent liberality for which the donor has been long known and honored, but is in singular harmony with that wisdom in managing affairs for which he is distinguished, and with that position in the world he has attained by skill, judgment, and integrity. It is deemed by the Corporation a high privilege, and a great reward for their labors, to be the stewards of such bounty; and they pledge their best efforts to carry faithfully into execution the enlightened suggestions with which the letter accompanying the donation is filled.

The wish expressed in it that the contemplated School "may be honorable to the University, and useful to the country," is connected in their minds with the pleasing conviction that such an example is honorable and useful in a wider sphere; that it is honorable not merely to the individual who offers it, but to the land in which he lives, and that it will be useful, not to the country only, but to mankind.

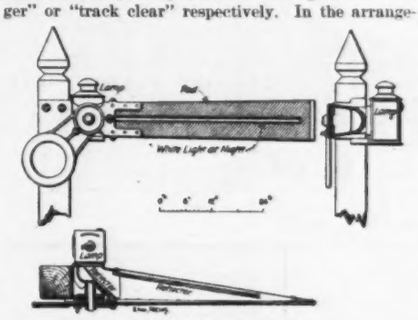
(Signed) JAMES WALKER, Sec'y.

"It is deemed by the corporation a high privilege to be the stewards of such bounty; and they pledge their best efforts to carry faithfully into execution the enlightened suggestions with which the letter accompanying the donation is filled." How did the corporation fulfill this pledge? It must be assumed that they had read over the letter before they passed this resolution, and that they spoke understandingly when they gave this solemn pledge to carry its suggestions "faithfully into execution." We postpone answering our own question, by giving a sketch of the subsequent history of the school, until our next issue, that the contrast between promise and performance may not be too sharp.

ILLUMINATED SEMAPHORE ARM.

The Union Switch & Signal Co., of Pittsburg, Pa., brought out a signal with an illuminated semaphore arm some years ago, and a slightly modified form has been recently made, which we illustrate herewith. The makers state that the signal is the same as operated on the Pennsylvania R. R. lines west of Pittsburg, the only difference being that the opening has been increased in length and decreased in width. The length of the slot extends nearly the entire length of the arm or blade, but the width has been decreased to 1¼ ins. Besides this, it is found that by introducing a ground glass the rays of light are more defined, and at a distance appear sharper and more distinct than with ordinary glass. These are the only changes that have been made in the original signal.

The operation of the signal is very clearly shown by the cuts, a horizontal or inclined strip of white light indicating the position of the signal at "danger" or "track clear" respectively. In the arrangement shown no colored lights are used, being for a position signal day and night. If a colored light is desired, the iron end of the arm is extended to carry a red glass disk clear of the signal post, the same lamp supplying the light by means of a reflector and lens. By enlarging the iron part of the arm to carry two disks, one red and the other green, the signal can be used to indicate three positions, "danger," horizontal strip of white light and red disk; "caution," white strip at an angle of 45° and a green disk; "track clear," vertical white strip and white disk. The lamp and arm are provided with back lights. The casting comprises the counterweight, and has an opening through which the light from the lamp is admitted to the interior of the arm. The arm is hollow and air-tight, made of wood or metal, with a slot in the face covered with a strip of glass, and provided with a reflector of sheet metal. The lamp is detachable and is of ordinary construction. The signal may be made with two blades and fittings on one post and employing one lamp, for use as a station signal where both directions of track are to be signaled. This illuminated semaphore signal is manufactured by the Union Switch & Signal Co., under the patents of Messrs. Spicer and Schreuder.



Illuminated Semaphore Arm.

THE BOSTON STREET DEPARTMENT.

On March 2, 1891, the Board of Aldermen of the city of Boston passed an ordinance establishing a Department of Streets to be in charge of a superintendent who should perform the duties previously performed by five heads of departments, namely, the superintendents of streets, sewers, sanitary police and the commissioner of Cambridge bridges. Mr. H. H. Carter was appointed to the new office, with Mr. Henry B. Wood as executive engineer, and with deputies in charge of divisions. From an advance copy of the valuable report of this department for the 13 months, Jan. 1, 1891, to Jan. 31, 1892, we abstract the following:

First, it is interesting to note that the total expenditures of the department for the above-named 13 months, including new construction, repairs, etc., were $3,620,490. This sum was divided as follows: Expenses of central office, $16,050; paving, $1,985,616; sewers, $717,359; sanitary division, $509,342; street cleaning, $215,465; bridges, $164,328; Cambridge bridges, $11,866; street police, $464.

The report contains a detailed list of contract prices for 1891. Paving blocks of large size in lots of 100,000 to 300,000 were delivered, generally at wharves, for from $69 to $78 per thousand, most of the blocks being furnished by the Cape Ann Granite Co. at $72.95 per thousand. A lot of 200,000 paving brick was delivered on Boston streets for $11.50 and another lot for $12.50 per thousand. North River flagging on the Boston wharves cost 52½ and on the street 57½ cts. per sq. ft. Edgestone on the wharves cost 73 cts. per lin. ft. Spruce lumber delivered to the different paving districts ranged from $15.38 to $17.75 per thousand, with an extra price of from $1.00 to $2.25 for planing. Bank gravel cost from $1.39 to $1.87 per double, and 70 to 98 cts. per single load, delivered to paving districts; bank sand, $1.35 to $1.96, and 67½ to 98 cts., as just stated. Beach gravel delivered in the city cost 71 cts. per ton.

For different kinds of paving, the following were the contract prices per square yard: Granite blocks on concrete foundation, $2 to $2.76; granite blocks on gravel foundation, 95 cts. to $1.52; asphalt on concrete foundation, $2.75 to $3.60; asphalt on existing pavement, $2; brick on gravel foundation, $2.40 and $2.75; asphalt blocks on gravel foundation, $2.85 and $3.10.

For setting edgestones the prices per lineal foot were as follows: Granite blocks on concrete foundation, 30 and 39 cts., and on gravel, 15 to 55 cts.; for asphalt on concrete, 18 to 42 cts.; brick, or asphalt block paving, 15 cts.

For laying brick sidewalks the prices ranged from 43 cts. to $1.32 per sq. yd., and for laying crosswalks, 27 cts. to $2.74; stone gutters, 32½ cts. to 72 cts.

The price per 2,000 lbs. for hauling stone from crushers ranged from 25 to 49 cts. for a distance of one mile, 35 to 69 cts. for two miles, and was 50 cts. for three miles, the latter price being in connection with contracts for 25 and 35 cts. for distances of one and two miles respectively.

On sewer work some of the contract prices per cubic yard were as follows: Rock excavation, $5; brick masonry with American cement mortar, $4.75, $5.25 and $5.40, and with Portland cement mortar, $5, $5.30 and $5.75; concrete, $3.50, $4 and $5; earth excavation, below grade, 80 cts.; gravel refilling below grade, 50 cts.

Among miscellaneous prices the following are noted: Lease of ledge lots at 10, 18 and 45 cts. per ton of stone removed; stone bought for arched rough masonry culvert, $3 per cu. yd.

During the busy season the engineering force of the paving division consisted of 12 men, there being two field parties and an office assistant. Plans and profiles of each street to be paved were prepared, quantities estimated, and general specifications previously prepared were filled in. This work was done under the direction of the City Engineer, Mr. Wm. Jackson.

Contracts were let for much of the work, the city furnishing all material except paving gravel, which was included in the contractor's price. There were 17 contracts, covering 4.35 miles of streets and aggregating in cost, exclusive of material furnished by the city, $169,161. The total amount of work of various classes and the average cost of each was as follows, the figures being for labor and paving gravel only: 53,444 sq. yds. granite block paving on gravel, $1.155, and 9,294 sq. yds. on concrete base, with pitched joints, $2.727; 15,189 sq. yds. asphalt paving on concrete base, $3.635, and on old base, $2.25; 31,000 lin. ft. edgestone, $.329; 22,417 sq. yds. side-

walks, retail, $.836; 3,078 sq. yds. flagging crosswalk, $1.184.

The average cost of granite paving blocks per square yard was $1.90, including cutting and wharfage, the contractor carting the blocks when necessary at the above prices. The average total cost of block paving on gravel is given as $3.05, the contractor removing 13 ins. of old material, grading and rolling the road-bed and furnishing 6 ins. of new gravel.

During the year ending Jan. 31, 1891, the drawbridges known as West Boston, Canal and Prison Point were opened a total of 8,040 times, and a total of 6,070 vessels passed through the draws.

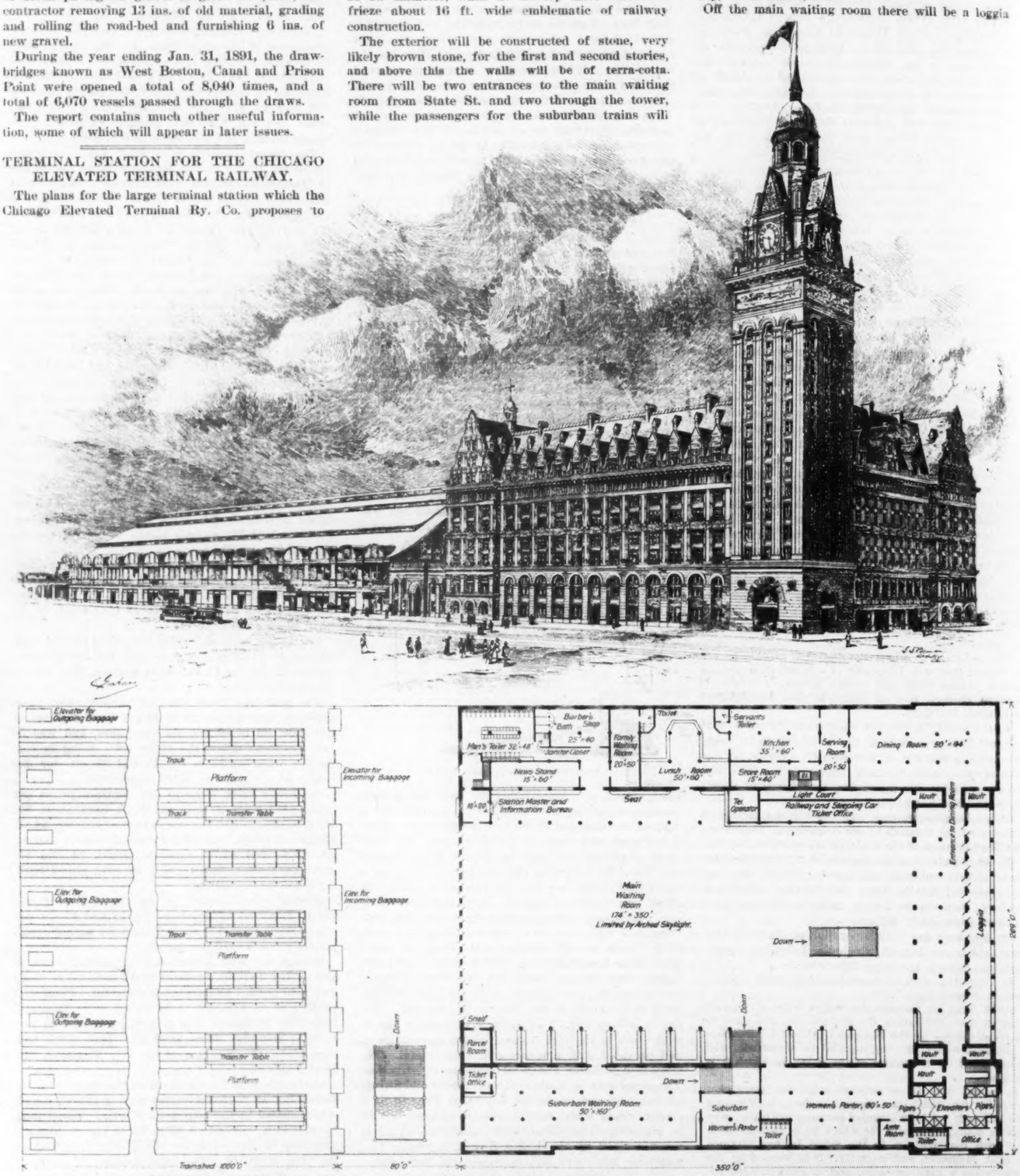
The report contains much other useful information, some of which will appear in later issues.

TERMINAL STATION FOR THE CHICAGO ELEVATED TERMINAL RAILWAY.

The plans for the large terminal station which the Chicago Elevated Terminal Ry. Co. proposes to erect at State and Twelfth Sts., are now completed. Mr. S. B. Beman, of Chicago, is the architect. The main building will be eight stories high and surmounted by a steep tiled roof, and will have a frontage of 350 ft. on State St., the style of architecture being that of the English renaissance. About 80 ft. south of this main building will be a trainshed with a length of 1,000 ft. on State St. At the corner of the building will be a tower 60 ft. square and 420 ft. high to the top of the flagstaff. In the tower there will be a clock with dials on each side 19 ft. diameter, while at the top there will be a frieze about 16 ft. wide emblematic of railway construction.

The exterior will be constructed of stone, very likely brown stone, for the first and second stories, and above this the walls will be of terra-cotta. There will be two entrances to the main waiting room from State St. and two through the tower, while the passengers for the suburban trains will reach the trains from the south end of the main building through the court between the latter and the trainshed. The fronts of the ground or first story of both the main building and trainshed will be leased for stores, with the exception of the space used for entrances. The main waiting room will be 174x350 ft., and will be arched, with a skylight overhead, this being the size of the court by which the offices above will be lighted. Opening onto this room there will be a suburban waiting room 50x160 ft., ladies' parlor 50x80 ft., and dining rooms, barber shop, news stands, etc.

Off the main waiting room there will be a loggia 18 ft. wide and about 130 ft. long, beneath which will be a carriage entrance to the elevators, and steps leading up to the grand waiting room. This carriage court will be 150x50 ft. The upper part of the building, including the tower, will be used fo-



PROPOSED TERMINAL STATION OF CHICAGO ELEVATED TERMINAL RAILWAY; S. S Beman, Architect.

offices, of which there will be 106 on each floor. In the trainshed will be 14 tracks, with a transfer table by which trains can be immediately transferred from one track to another, so that they can arrive and depart without interruption. At the north end of the shed there will be eight elevators for receiving and lowering the baggage from incoming trains to the baggage rooms beneath, while at the south end there will be the same number for handling outgoing baggage. The steel roof trusses of the trainshed will have a clear span of 289 ft., and will be of elliptical form, rising to a height of 125 ft. They will be placed 40 ft. apart and arranged in pairs braced and riveted together. The platforms of the trainshed will be of Portland cement, and the tracks will be 12 ins. below the platform level.

The entire structure will be of fire-proof construction, and equipped with all modern conveniences. The estimated cost is $3,500,000. It is intended to begin work as early as possible, and it is thought that two years will be required to complete it. The company's terminal railway project was described in our issue of Jan. 2.

AN AEROPLANE DIAGRAM.

By Charles W. Hastings.

The object of the accompanying chart, designed and copyrighted by the writer, is to show some of the elements which enter into soaring flight (viz., area, velocity, angle of inclination and power required), and their relations to each other. The diagram is constructed by the use of three formulas, two of which are empirical, the other rational.

The first is that for wind pressure upon a plane surface at right angles to it; it is:

$$P = 0.00327\ V^2 S \qquad (1)$$

(P) being the pressure in lbs., (V) the velocity of the current in miles per hour, (S) the area of the exposed surface in square feet. The coefficient 0.00327 is that determined by Prof. S. P. Langley, and may be found upon page 22 of his "Experiments in Aerodynamics," the figures there being 0.008, which is the coefficient to be employed if metric units are used.

The other empirical formula is:

$$Pr = P \frac{2 \sin A}{1 + \sin^2 A} \qquad (2)$$

(P) being the same quantity as above, (A) the angle between the plane surface and the current upon it, (Pr) is the resulting pressure, and according to the law of fluid pressure is normal to the surface. This formula is by Col. Duchemin, of the French Army, and has been in existence a number of years.

These are probably the most accurate formulas of their kind in existence. In any case their inaccuracies will not affect a number of conclusions which may be deduced from the diagram.

The rational formula is:

$$HP. = 0.00266\ W\ V \tan A$$

in which HP. is English horse-power, and (W) the weight in pounds supported by the aeroplane. The author believes this formula to be original, and it is applicable to all fluids.

If (Pr) is the normal pressure upon a plane surface the lateral pressure will be Pr x cos a. The lateral pressure is that at right angles to the current, and in the case of the aeroplane is the uplift, W:

$$W = Pr \cos A \qquad (3)$$

The pressure upon the plane in the direction of the current (R) is:

$$R = Pr \sin A$$

By definition, power is resistance into velocity. The horse-power is 33,000 ft. lbs. per minute, or 375 mile lbs. per hour, since V and R are in the latter units:

$$HP. = \frac{V\ R}{375} = 0.00266\ V\ R.$$

Substituting for R its value as above:

$$HP. = 0.00266\ V\ Pr \sin A \qquad (4)$$

Dividing equation (4) by (3) we obtain:

$$HP. = 0.00266\ W\ V \tan A$$

If the value of P as given in (1) is substituted in (2):

$$Pr = 0.00377\ V^2 S \frac{2 \sin A}{1 + \sin^2 A}$$

$$\text{From (3) } Pr = \frac{W}{\cos A}$$

Substituting, we obtain:

$$W = 0.00327\ V^2 S \frac{2 \sin A \cos A}{1 + \sin^2 A}$$

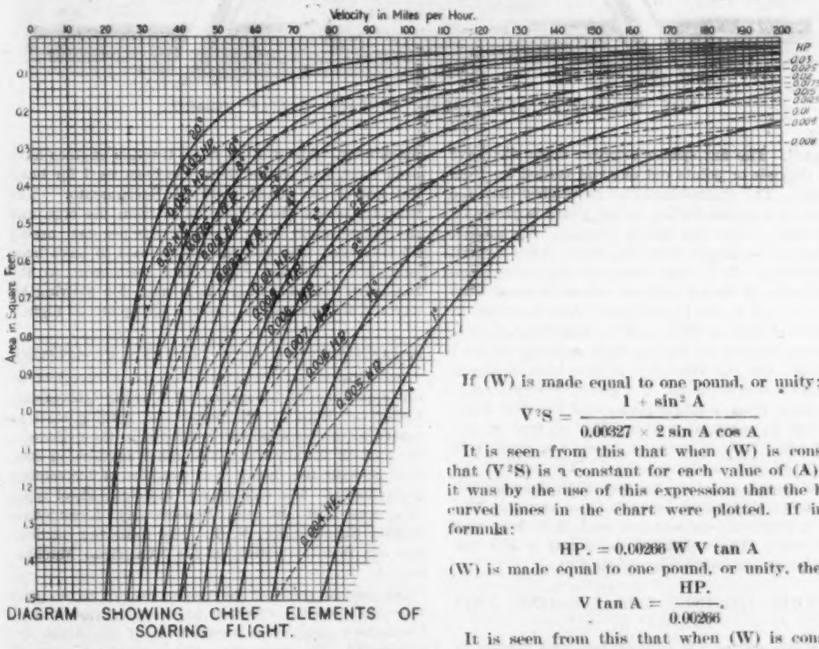


DIAGRAM SHOWING CHIEF ELEMENTS OF SOARING FLIGHT.

If (W) is made equal to one pound, or unity:

$$V^2 S = \frac{1 + \sin^2 A}{0.00327 \times 2 \sin A \cos A}$$

It is seen from this that when (W) is constant, that ($V^2 S$) is a constant for each value of (A), and it was by the use of this expression that the heavy curved lines in the chart were plotted. If in the formula:

$$HP. = 0.00266\ W\ V \tan A$$

(W) is made equal to one pound, or unity, then:

$$V \tan A = \frac{HP.}{0.00266}.$$

It is seen from this that when (W) is constant, that (V tan A) is a constant for each value of HP. and it was by the use of this expression that the lighter curved lines were plotted over the heavier ones. The author is under obligations to Mr. O. Chanute for the information which enabled him to construct the chart.

ASPHALT PAVEMENTS IN NEW YORK.

In the last quarterly report of Thomas F. Gilroy, Commissioner of Public Works of New York, is a report by Stevenson Towle, consulting engineer, on pavements. We make the following abstract:

The aggregate length in miles of the various types of street pavement in New York to date is as follows, including miles laid during the past year:

	Stone miles.	Asphalt miles.	Macadam miles.	Wood miles.
Laid in 1891.....	18.92	7.60	1.50	0.
Total laid to date.	320.62	27.77	22.25	0.3
Grand total.....				370.67 miles.

In connection with stone block pavement it is pointed out that under the allowance of 1 in. in height of blocks, 7 to 8 ins., these pavements wear unevenly, though laid in the best manner on 2 ins. of sand and a concrete base. The stone paving of London and Liverpool is pitched with only 1-4-in. allowance in height and laid on a 1-2-in. bed of sand. The blocks are assorted as to size at the yards and sold to contractors, and though this method is costly it is recommended for New York as fully counterbalancing its cost by its better quality and durability.

In examining the two kinds of asphalt pavement laid in the year, Sicilian and Trinidad, Mr. Towle states that the Sicilian pavement permanently compresses under traffic, after several months, while the Trinidad attains its final compression as soon as laid. He recommends that the Sicilian rock asphalt pavement be laid to a depth that will secure 2 1-2 ins. after it has reached its ultimate compression. He finds the Sicilian pavement to be more slippery in damp and foggy weather than Trinidad, due to the impalpable limestone in the first as compared with the sharp sand that constitutes the body of the Trinidad.

Mr. Towle visited the Trinidad pitch lakes and found that the failure of our asphalt pavement, laid on part of 8th Ave. in 1890, was due to its coming from the village plots of La Brea and not from the Pitch Lake proper. He describes these Trinidad pitch deposits as follows as the result of a personal visit to the island of Trinidad in October, 1891:

Asphalt is found in different parts of Trinidad, but only in the district of La Brea (Spanish for "The Pitch") is it found in sufficient quantity for commerce, or of a quality suitable for street pavements. The wonderful Pitch Lake is situated there, and also with the extensive deposits of "iron pitch" and "land pitch" on the slope between the Lake and the Gulf of Paria. The lake is about one mile from the sea, at an elevation of 138 ft., and contains 115 acres. It is quite circular in shape, and the outlines are well defined. On the south the land rises gradually from the lake, and on the three other sides the land slopes uniformly from the lake to the sea.

The surface of the lake is not level. It has an inclination of a few inches in one direction, sufficient to drain off the frequent rainfalls. Besides this slight inclination, the surface has a fall of a few inches from the center toward all sides. Another and distinct characteristic is that the surface is not flat and even, but is formed of irregular, oval-shaped flattened domes, or slightly convex surfaces, separated by channels of water a few feet wide and a few inches deep, flowing toward outlets. There are several small islands, from 50 to 60 ft. in diameter, scattered over the surface of the lake, and resting on the asphalt itself. These islands have sufficient depth of soil to support the growth of quite large trees. The whole appearance of the lake is very odd, strange and difficult to describe. In color it is a dark chocolate brown, and looks very like a patch of mushrooms flattened out and pressed closely together, separated only by the narrow and shallow channels of water already described. In the center of the lake is a space of several hundred square feet of soft fluid asphalt. This is the celebrated "Pitch" or "Boiling Spring." Here the temperature is colder than in the solid parts of the lake. The appearance of boiling is due to the escape of large volumes of sulphureted hydrogen gas, which keeps the liquid mass violently agitated. This "spring" is commonly, but erroneously, thought to be the source of supply. In fact, it is the last of the asphaltic deposits, and is ages more recent than the deposits of "iron" and "land pitch," and much more recent than the solid part of the lake itself. This very fact should prove conclusively that the lake has never overflowed to form the deposits outside it, and that these deposits of "iron" and "land pitch" had no such origin.

The surface of the lake is sufficiently firm to support the weight of loaded carts. The asphalt is mined for commerce from different parts of the lake to a convenient depth of about three feet. It is easily excavated with picks, loaded directly into carts, and hauled to the shore ready for shipment. A marked peculiarity of the Pitch Lake is, that the pits or excavations made during the day, fill up during the night, and in a few days no trace of them can be found. This is due to the great viscosity of the lake asphalt, and is one of the features which distinguishes it from all other asphalts found in this district. On the slopes from the lakes to the sea, and beneath the sea itself, are found the vast deposits known as "iron" and "land pitch." The greater part of these are covered with several feet of earth, supporting a dense tropical forest growth. The village of La Brea is over these deposits, the houses and streets resting directly on the pitch itself. These deposits

are known by American dealers as "overflow pitch," but the inhabitants and geologists term them "iron" and "land pitch." The asphalt from these deposits varies in color from gray to black. The "iron pitch" exists in extensive compact masses or detached deposits, and is extremely hard and brittle, and almost black in color. The "land pitch" is found mixed with more or less dirt and foreign matter, and varies in color from gray to black. Both kinds are mined from the village lots and from deposits on both sides of the road leading from the village to the lake. These village plots are the ordinary size village lots, and are generally occupied by the cabins of the owners, who either mine the deposits themselves or lease them to others for mining. The asphalt is carted to the shore and piled in heaps ready for shipment, which is almost exclusively to the United States. The cargoes are often made up of asphalt mined from several different deposits. This accounts for the great variety met with in the same shipment. I noticed one pile made up in this way, and adjoining it a pile of "lake" asphalt. The difference in the two was very marked. The pile of "land" and "iron pitch" was of a variety of colors, from gray to black, lusterless as brittle, and mixed with earth and decomposed asphalt. This latter feature was owing, no doubt, to careless sorting and "cutlassing," as the cutting and trimming off the decomposed surfaces of the deposit is called. The pile of asphalt from the lake was bright and uniform in color. Another peculiarity of the "iron" and "land pitch" is that when excavations are made the walls of the remaining asphalt do not run in and fill up the excavation. The angles and projections only are rounded off and softened by the sun's heat. This shows that these kinds flow but slowly, if at all, and in this respect are very different from the lake deposit.

The different asphalts found on the Island of Trinidad have, undoubtedly, a common origin. Geologists, however, differ on this point. Messrs. Wall and Sawkins, Government geologists, hold that the asphalts are of vegetable origin, and formed in the same way as peat and coal. In this opinion most geologists agree. Others claim that the asphalts are of volcanic origin, and some hold that the source is to be found on the mainland of South America opposite, where there are found vast deposits.

The Government geologists, in their report of 1860, describe the asphalt found on the Island of Trinidad as three kinds: " 'Glance,' which is rare and very brittle, and but little used; 'asphaltic oil,' found in very small quantities and of poor quality; 'asphalt proper,' containing from 20 to 35 per cent. of earthy matter, preserving its elasticity, which, however, gradually disappears on long exposure to sun and atmosphere. This is a very essential characteristic to which many phenomena exhibited are attributed."

Nine samples of asphalt brought home by Mr. Towle were examined by Messrs. Ricketts & Banks, with the following results:

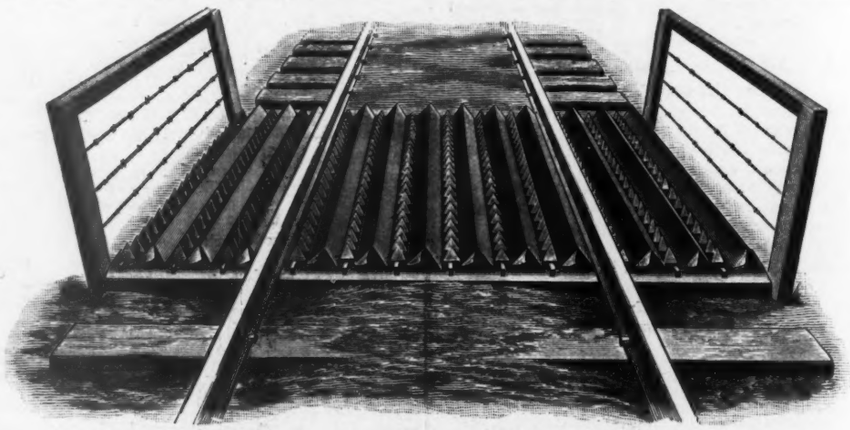
Sample	Matter Extracted, Carbon Bisulphide. (Bitumen). Per cent.	Melting Point. Deg. F.	Oils at 400 deg. F. Per cent.
No. 5	48.89	245	1.88
No. 6	49.63	165	1.32
No. 7a	52.10	160	3.55
No. 7b	50.12	160	2.91
No. 7c	49.73	160	2.27
No. 7d	53.77	160	4.16
No. 8	48.27	170	1.72
No. 9	46.32	250	2.20
No. 10	45.08	185	0.48

As the percentage of moisture in the sample is constantly varying, all of the above determinations were made on the dry samples. The mineral matter in the samples consisted chiefly of silica, alumina, oxide of iron and lime in all cases. In 1891 76,557 tons of asphalt, about one-half raw and the other half refined, were obtained from the "Lake," as compared with 729 tons obtained from outside the lake. Between 1888 and 1891 41,177 tons of raw and 4,827 tons of refined asphalt were imported into the United States, and this was mined exclusively by the Trinidad Asphalt Co., and was imported by the Barber Asphalt Paving Co., the Warren-Scharf Asphalt Paving Co., and the Crawford Paving Co. Asphalt from outside the lake is only imported by other companies. The full duty on the lake asphalt is $1.60 per ton and on the asphalt from other sources, $1.20. Any one can purchase lake asphalt who will pay the price. Mr. Towle recommends that asphalt from the Pitch Lake at La Brea be hereafter made the standard for all New York pavements using asphalt from Trinidad.

THE KALAMAZOO STEEL SURFACE CATTLE GUARD.

The evolution of the surface cattle guard has been a rapid one. It is but a few years since the old pit guard, which had so long been the standard protection at highway crossings, began to be replaced by surface guards of wooden slats; these soon gave way on the most progressive and best managed roads to the more permanent and durable steel slats with sharp edges. But these, while avoiding the dangers of the old pit guard, have not always proved as efficient as their introducers expected. The razor-backed hogs of the South crossed them with little trouble, and cattle will also cross them if sufficiently hard pressed.

The ingenuity of inventors was therefore taxed to devise a form of guard which should so severely punish an animal at the first step upon it that it would turn back as from a barbed wire fence. Several of these recently designed guards have been illustrated and described in this journal. We show herewith a perspective view of a guard recently brought out by the Kalamazoo R. R. Velocipede & Car Co., of Kalamazoo, Mich. The guard is formed from a single plate of steel on which a series of sharp ribs are struck up, running lengthwise of the guard. The flat spaces between these ribs have sharp tongues or points cut out and turned up from the plate. The sharp-edged ribs are higher than the tongues, so a person falling on the guard is protected from injury from the sharp tongues. An animal stepping on the guard, however, either splits its hoof on the sharp rib or else the foot slips down the sloping sides of the rib onto the sharp tongues. This guard was not in the Indianapolis tests described in our issue of Dec. 5, 1891, and is therefore not open to the imputation of having been actually crossed by cattle. On the contrary, it has been designed since these tests occurred. The guard is very strong, being made from a single plate, and the ribs make it as stiff as corrugated iron. The surface of the ground being entirely covered, weeds and grass will not grow up underneath the guard. The ends of the ribs are closed, and thus no hook-shaped projection is left to catch trailing brake rods or chains. The guard is made in four sections, each 9 ft. long and 26 ins. wide. The weight of the guard is 375 lbs. and the manufacturer's list price is $20.



THE KALAMAZOO NEW STEEL SURFACE CATTLE GUARD.

TRACTION ENGINES FOR LOGGING AND PLOWING.

A traction engine for hauling logs and lumber is to be used by Towles Bros., of Towles, Alta P. O., Cal. The length of haul is 5½ miles and the maximum grade 11.1 per cent. The engine was built by the Daniel Best Agricultural Works, of San Leandro, Cal., and Mr. Best informs us that it is one of their regular 50-HP. road locomotives or traction engines, built especially for the logging and hauling business. These engines are said to be a great success, and the works are kept busy filling orders for them. The weight of the engines is 13 tons, and they are made to run at a speed of three miles an hour, hauling 50 to 75 tons over any ordinarily good road, and ascending grades of 5 to 9 per cent. The logging cars are made by J. F. Hill, of Sacramento, Cal. The engines are carried on three wheels, the vertical boiler being between the two larger wheels, and they are fitted with a winding drum or rope for hauling logs to the cars. One of these engines is reported as making five trips per day, running 30 miles per day and hauling 14,000 to 16,000 ft. of logs each trip, at a cost 50 per cent. cheaper than that of hauling by teams. The engines cost $4,500, or $90 per HP. The same works also build traction engines for steam plowing, harrowing and other farm work, as well as for hauling. The boilers of these engines are a combination of the vertical and horizontal types. The main part of the boiler is vertical, 4 ft. diameter, with 160 tubes 2 ins. diameter and 5 ft. long. The firebox is horizontal, 6 ft. 6 ins. by 3 ft. 8 ins., and 3 ft. high. Wood is used for fuel. The engine carries 320 gallons of water and a third of a cord of wood. The driving wheels are driven by gearing, and for a 40-HP. engine are 8 ft. diameter and 2 ft. 2 ins. wide over the tires. The front or steering wheel is 5 ft. diameter and 18 ins. wide. Mr. Best's patent variable eccentric is used on these engines, by which the travel of the valve can be regulated, and a belt wheel is fitted for using the machine as a stationary engine to drive machinery. About 30 of these traction engines have been built, and one of them has been used for hauling gravel for street work at Sacramento. The gravel pits are about four miles from the city, and the engine made seven or eight trips per day, taking 72 tons each trip, and the cost is said to have been very low. Another engine has been sent to the Sandwich Islands, where it is used for plowing by day and for running an electric light plant at night.

A LOCOMOTIVE FOR TESTING PURPOSES.

An eight-wheel locomotive has been installed at the experimental laboratory of Purdue University, Lafayette, Ind., for the purpose of making tests in regard to the horse-power developed in the cylinders, the pull on the drawbar, and other matters in connection with the theory and practice of locomotive performance. The engine is of the eight-wheel type, and was built by the Schenectady Locomotive Works, Schenectady, N. Y. The following particulars are from an article in the "American Machinist:"

The pull (or push) of the locomotive can be weighed while the power is absorbed by heavy friction brakes. The brakes used are a modification of the Alden dynamometer. The locomotive, which weighs 43 tons, is mounted with its drivers upon heavy supporting wheels, free to revolve in either direction by contact with the drivers. The prolonged axles of the supporting wheels are each provided with a large cast iron disk, keyed to the shaft, which is allowed to rotate in a closed case between two thin plates of copper, which plates can be forced against the disk by hydraulic pressure, as in the Alden brake. Each brake was designed for a load of 200 HP., with a maximum water pressure of 40 lbs. per sq. in. under a moment of 10,500 ft.-lbs. The shaft to which the disk is keyed is 7⅞ ins. diameter. The disk is 56 ins. diameter and ⅝ in. thick. It is provided with suitable oil grooves on each face, by which the lubricating oil which enters the hub is constantly circulated, thus allowing a thorough distribution of the oil to be maintained over the rubbing surfaces.

The locomotive is free to move forward or backward only through a very small distance (about a quarter of an inch), its tendency to forward motion being measured by a dynamometer consisting of a system

of levers and weights connected to the draw-bar, by which the traction of the engine can readily be weighed. Any desired load or speed can be maintained by means of the powerful friction brakes which are bolted securely to stone foundations—in this respect differing from the Alden dynamometer, which is free to rotate through a small arc.

The boiler may be fired with coal in the usual manner; provision is also made to supply steam from an auxiliary boiler if desired. Each cylinder is fitted with a pair of indicators and suitable rigging for taking cards. A large Sturtevant fan, actuated by an independent steam engine, is placed above the locomotive smoke stack, but not in connection with it, and takes up and carries off through the roof whatever would otherwise be discharged into the building.

We see no reason why a locomotive thus installed should not prove a very excellent aid to instruction and experiment, and the example strikes us as worthy of imitation.

NEW YORK STATE CANALS.

The report of Mr. John Bogart, ex-State Engineer, was presented to the legislature in April, and gives some interesting information in regard to the state canals. The improvements now in progress will give the Erie Canal a full depth of water of 7 ft. at all points; that standard depth not at present existing at many points on account of deposits of mud and silt. It is also intended to make the locks twice their present length so that two canal boats may pass without being uncoupled. All the important traffic on the canal is now carried in "double headers," two boats connected together, which method secures a large economy in transportation. A large proportion of the boats are still drawn by horses, but there is a constant increase in the number of steam canal boats, which are propelled by a screw, and generally push one consort in front and tow two behind.

The report gives an interesting history of the introduction of steam upon the canals, and incidentally of the original construction, dimensions and traffic of the waterways of the state. The first water communication which was developed in the state of New York was at the suggestion of Governor George Clinton in 1791, and was carried out by a company called the Western Inland Lock Navigation Co. This improvement gave the water route from Schenectady up the Mohawk River to Little Falls, where there was a canal with locks, the ruins of which still exist; thence by the Mohawk to Fort Stanwix, now the city of Rome, and thence by Woods Creek, the Oneida and Seneca rivers to Seneca Falls. This route was opened in 1796 from Schenectady to Seneca Falls for boats carrying 16 tons.

In 1803 Gouverneur Morris brought forward the idea of a great canal to connect Lake Erie with tidewater in the Hudson, and he was probably the originator of this project. The Surveyor General, Simeon De Witt, with Mr. James Geddes as engineer, made a survey for such a route in 1808 and 1809, and in 1810 the legislature appointed as a commission to prosecute the matter Gouverneur Morris, Stephen Van Rensselaer, De Witt Clinton, Simeon De Witt, William North, Thomas Eddy and Peter B. Porter, with Mr. Geddes as engineer. This commission recommended substantially the present route of the Erie Canal, and De Witt Clinton introduced the bill in the legislature in 1811, appointing the same commission with the addition of Robert R. Livingston and Robert Fulton to push forward this work.

In 1817 De Witt Clinton presented to the legislature a system of finance for a canal fund which formed the basis of the law of that year, under which the Erie Canal was constructed. The board of Canal Commissioners was created, with De Witt Clinton as President. The first ground was broken for the Erie Canal at Rome, July 4, 1817, and the section from Utica to the Seneca River was completed in 1818, a boat called the "Chief Engineer" going from Rome to Utica. In 1823 the Champlain Canal was completed from Champlain to Albany, and on Oct. 26, 1825, the Erie Canal was completed from Buffalo to the Hudson. The first boat arrived in Albany from Buffalo on Nov. 23, 1825. The actual construction cost of the Erie and Champlain canals is stated as $7,853,009.

Mr. Bogart states that this original canal had a depth of but 4 ft., a surface width of 40 ft., and that the boats upon it could carry but 80 tons. The present canal boats have a capacity of 250 tons. The enlargement to the present depth of water of 7 ft. and the increased width was begun in 1836 and completed in 1862.

The report states that the freight on wheat from Buffalo to New York averaged about 3½ cts. per bushel during 1891, and at that rate there is very little profit to the owners, who are frequently the captains of the canal boats, and there is an absolute loss should the number of trips in a season be less than seven. If there is to be a continuance of the policy of maintaining the efficiency of the Erie Canal everything should be done to make the transport through the canal as easy and expeditious as possible. For this purpose the full depth of water must be secured, the locks lengthened and the canal maintained in thorough condition.

The Thomson-Houston Electric Co. has made a proposition to the Baltimore Belt Ry. Co. to operate its trains in the Howard St. tunnel by means of 80-ton electric locomotives. It will be remembered that the Belt Ry. is to be the terminal of the Baltimore & Ohio R. R. and that it passes under Howard St. in a tunnel 8,350 ft. in length. (Engineering News Dec. 12, and 19, 1891.) The electric locomotives are to take their current from a trolley wire running along the roof of the tunnel. According to the Baltimore "Sun," the Thomson-Houston Co. offers to supply the whole plant in working order and allow the railway company sufficient time to give it a fair trial. If not satisfactory the Thomson-Houston Co. will then remove the plant without cost to the railway company. Grades in the tunnel are light, but starting heavy passenger trains will require a locomotive of as much power as an ordinary express locomotive at least.

The Belgian State Railways have been given an appropriation of $1,106,400 by the Budget for 1892, issued in March. The amounts are as follows: 30 locomotives, $430,200; 30 tenders, $56,200; Westinghouse brakes, $9,100; wheels for locomotives, $16,000; 52 composite first and second-class cars, $190,000; 70 third-class cars, $190,720; 25 baggage cars, $33,000; 60 box freight cars, $73,120; tools and appliances at shops and stations, $30,000; plant for electric lighting, compressed gas works for car lighting, and plant for car heating by steam, $60,000.

The Belgian government has voted an appropriation of $60,000 toward the expenses of the exhibit of the art, industries, commerce and resources of Belgium at the World's Columbian Exposition. In accordance with the policy adopted in regard to such expositions, the government will not organize an official representative commission, but a committee has been appointed by the Superior Council of Industry and Commerce to secure exhibits from Belgian manufacturers, artists and others.

A historical exhibit of railway tickets and timetables has been arranged for by the Department of Transportation Exhibits of the World's Columbian Exposition, and its collection has been intrusted to Mr. Geo. De Haven of Grand Rapids, General Passenger Agent of the Detroit, Lansing & Northern, and Chicago & West Michigan railways. Those having in their possession old and rare tickets, timetables, etc., are requested to communicate with him.

The Meigs Elevated Ry. Construction Co., of Boston, Mass., shows the following balance sheet in its annual report:

Machinery	$5,000	Capital stock	$100,000
Patent rights	50,000	Debts	95,957
Profit and loss	140,957		
Total	$195,957	Total	$195,957

Tunnel widening for double track is in progress on the Pittsburg, Cincinnati, Chicago & St. Louis Ry. between Dennison, O., and the Ohio River. There are six tunnels, from 600 to 4,600 ft., in length. Two of them, 4,600 ft. and 2,200 ft. in length, are completed and lined with stone and brick, and another is widened and nearly ready for the lining. Other improvements are being made on this railway, and double tracking is being pushed through rapidly. Between Pittsburg and Columbus there are already 65 miles of double track. On the subdivision, between the Ohio River bridge and Dennison, O., 52 miles are being double tracked with 85-lb. steel rails rolled by the Illinois Steel Co. All the wooden and iron bridges between Pittsburg and Columbus are to be replaced with stone arch bridges. The ballast used is limestone and gravel; the former 18 ins. and the latter 24 ins. in depth.

The inroads of the ocean on the sand beaches along the New Jersey coast are to be investigated by the State and National Geological Surveys, with a view to the adoption of some system for protecting the valuable property at Long Branch, and other noted resorts, from destruction. Professor Smock, State Geologist of New Jersey, is inclined to favor the terracing of the shore on the system practiced in Holland.

The smoke nuisance is receiving increased attention in Pittsburg and Cleveland, since Chicago's Smoke Prevention Citizens' Committee began work with such good results.

A locomotive tire trust is said to have been formed by the Nashua Iron Co., the Standard Steel Co., the Latrobe Steel Co., the Midvale Steel Co., and the Chicago Tire & Spring Co. Messrs. M. C. Smyth, of the Latrobe Steel Co., and Wm. Burnham, of the Standard Steel Co., and the Baldwin Locomotive Works are named as chiefly instrumental in its formation.

The steel highway bridge from Galveston, Tex., across West Bay to the main land will cost $175,000. The structure will consist of 80-ft. steel, fixed spans on concrete piers and a swing span of 180 ft., and 2,340 ft. of pile trestle. There will be a roadway 18 ft. wide. The Missouri Valley Bridge & Iron Works, Leavenworth, Kan., have the contract.

A rock cut 2,500 ft. long and varying from 5 ft. to 51 ft., with an average of 25 ft. in depth is being made on the Champlain Railway division of the Delaware & Hudson Canal Co.'s railway between Crown Point and Port Henry, N. Y. The cut is in solid limestone rock and the amount of material to be removed is 30,000 cu. yds. Work was begun Jan. 20, and will be completed by May 1.

The electric light plant in use at Lima, Peru, is on the Thomson-Houston system, and is under the control of the Lima Gas Co. The company supplies 135 arc lamps and 2,000 incandescent lamps. Electricity is not used for lighting in any other part of Peru, but it is reported that the City Council of Arequipa is considering the subject of introducing electric lighting. The city of Lima has over 20 miles of street railways, upon which 30 cars are drawn by horses and mules, and it is reported that negotiations are under way for the equipment of these roads with electric motors.

A great river improvement scheme is being discussed in Texas. It is proposed to make the Trinity River navigable by building dams and locks as far as Dallas, or perhaps, to Fort Worth, a distance of over 250 miles from the Gulf, by the expenditure of private capital.

The Love electric conduit system for street railways is being tested in Chicago on an experimental line 1¾ miles in length, which was completed about two months ago. The cost of the system is stated to be not over $25,000 to $30,000 per mile. The system has recently been investigated by a committee from the Toronto Board of Aldermen, and is being thoroughly tested by the managers of the C. T. Yerkes system of railways, in Chicago.

A pneumatic dispatch line, about 3,000 ft. in length, is to be introduced in St. Louis by the Post Office Department, connecting the general post office with a sub-station in the Cupple's Building. A dispatch and return main will be laid, each 4 ins. in diameter. The route will be through the St. Louis Bridge Co.'s tunnel, so the expense for right of way will be small. The Department is believed to contemplate the extended use of pneumatic tube service in the principal cities, provided the experimental line proves successful.

The latest scheme for swift mail transportation is an aerial mail carrier buoyed up partially by a hydrogen chamber and partly by two trolley wires, on which it runs. From these wires it takes an electric current which operates a motor driving the carrier at enormous speed. The inventor is B. E. Osborn, of Auburn, N. Y.

A double barrel locomotive boiler for a French railway was noted in our issue of April 21, and a similar arrangement has been designed by an American superintendent of motive power. In the French engine the upper barrel has no tubes, but is intended to increase the capacity of the boiler. In the American design the hot air and gases from the firebox are to be led through to the smokebox, returned through passages between the two barrels to a chamber over the throat sheet, and then forward again through tubes in the upper barrel to an upper smokebox. The upper barrel will be merely a steam space, and will be fitted with a dome. The exhaust pipe will pass up into the smokebox of the upper barrel.

The plan of the improvement of the Aransas Pass, at Aransas Harbor, Tex., embraces the use of caissons and is intended to secure the best and quickest results with the least expense, leaving the full completion and strengthening of the work till later. The plans were prepared by Mr. Haupt, of Pennsylvania, and Mr. Nelson is in charge of the work.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

LITTLE FALLS & DOLGEVILLE.—Nine of the eleven miles of this railway from Little Falls to Dolgeville, N. Y., have been graded and tracklaying will begin by May 20. The iron work of the bridge over Ransom Creek is being erected. The bridge will be 440 ft. long, and 90 ft. above the bed of the creek, and will consist of six spans.

WABASH.—A press dispatch states that 30 miles of the line from Montpelier, O. to Hammond, Ind., will be completed by June 1, and that the entire 154 miles will be completed by Nov. 1. The contractors are B. F. Johnston & Co., of Goshen, Ind.

WILKES BARRE & EASTERN.—Local papers state that about 250 men are now at work on this line, and that the grading is well advanced on about five miles. Thirteen miles more are located, ready for graders. The line is projected to run from Wilkes Barre to Stroudsburg, Pa., 60 miles. Ch. Engr., I. E. Hartwell, Wilkes Barre, Pa.

PORTLAND & RUMFORD FALLS.—Tracklaying has been begun on the extension from Gilbertsville to Rumford Falls, 14 2-5 miles, and it is expected to have the line completed by July 1.

BALTIMORE & OHIO.—The contract for the first section of the Fairmount, Morgantown & Pittsburg R. R. from Morgantown, W. Va., north has been let, and further contracts will be let soon. Work from Uniontown, Pa., south has been in progress for some time. The total length of the line from Uniontown, Pa., to Morgantown, W. Va., is 33 miles.

READING, LANCASTER & BALTIMORE.—The contract for building this line from Reading, Pa., to Perryville, Md., 75 miles, has been let to H. E. Warren who has headquarters at Reading, Pa. About 150 men are now at work and this force is to be increased as fast as the line is located ready for the graders. The estimated cost of the line is $36,000 per mile.

Projects and Surveys.

WINSLOW & SEA ISLE CITY.—It is rumored that an endeavor is to be made to build a railway from Winslow junc., to Sea Isle City, N. J., to replace the Philadelphia & Seashore R. R. between those points which, it is stated, is to be closed up. Among those interested are Jas. E. Gorman, 520 Walnut St., Philadelphia, Pa., and others.

MIDDLEPORT, POMEROY & SYRACUSE.—A railway company by this name has been chartered in Ohio. Among the incorporators are J. B. Milliken, C. P. Crane, W. R. Hodge and others.

PROVIDENCE & NORWICH.—At a recent meeting of the directors of this company the following officers we re elected: Pres., Franklin Mead, Boston, Mass.; V.-P., Oscar W. Rogers, Chicago, Ill.; Secy. and Treas., Samuel T. Douglas, Providence, R. I. The proposed road will run from Providence, R. I., via Johnston, Cranston, Coventry and West Greenwich to a point near Sterling, Conn., and also from Providence to a point near Attleboro, Mass.

DAVENPORT, MIDDLEBURG & DURHAM.—At a recent meeting of the directors of this company, whose incorporation was noted in our issue of April 28, the following officers were elected: Pres., W. E. Thorne, Middlesburg, N. Y.; V.-P., E. M. Harris, Cooperstown, N. Y.; Secy., John H. Cornell, and Treas., J. Edward Young.

ALTOONA SHORT LINE.—The surveys have been completed for the main line from Everett to Orr Hill Station, Pa., 40 miles, and work is now in progress on the branch to Williamsburg.

TOMHICKEN & MILNESVILLE.—Chartered in Pennsylvania to build a railway from Tomhicken to Milnesville, Pa., 8 miles. Pres., J. I. Hallenbach, Hazleton, Pa.

OHIO SHORT LINE.—Chartered in Ohio to build a railroad from Steubenville to Toledo, O. Among the incorporators are: S. C. Mabrey, J. B. Milleken and A. P. Crane.

CLIFF-TOP INN ASSOCIATION.—This company proposes to build an incline railway to the summit of Helderberg Mountain. The road will be about two miles long, five-eighths of a mile, making an ascent of 800 ft. Jas. H. Manning, Mayor, Albany, N. Y., is at the head of the enterprise.

Southern.—Existing Roads.

PICKENS.—Julius E. Bogg, Pres., Pickens, S. C., writes that the surveys have been completed for this railway from Easley to Pickens, S. C., 9¼ miles, and the contract for building the line let to Buckhalter, Grandy & Co. The line is through a rolling country, affording comparatively easy work. There will be two small bridges over Rice and Wolf creeks. About 4 miles of the right of way has been secured, and $25,000 in bonds and cash have been obtained in aid of the enterprise. It is expected to have the line completed by Oct. 1, 1892.

ILLINOIS CENTRAL.—It is stated that engineers are making surveys for an extension of the Yazoo & Mississippi Valley branch, from Parsons to Grenada, Miss.

ATLANTIC COAST LINE.—Surveys are reported in progress for an extension from Rimini Station to Orangeburg, S. C. It is stated construction will begin as soon as the surveys are completed and the extension completed as soon as possible. The extension will be about 25 miles.

WATAUGA VALLEY.—The stockholders of this company held a meeting May 2 to consider the issuance of bonds to provide for the completion of this railway, between Watauga and Watauga Point, Tenn.

MIDDLE GEORGIA & ATLANTIC.—It is stated that work will be resumed on the partly graded line between Covington and Machen, Ga., 20 miles, within 30 days. Arthur Pew, Savannah, Ga., is Chief Engineer.

CHATTANOOGA & DURHAM.—Grading has been completed and tracklaying is now in progress upon this railway from Chickamauga to Durham, Ga., 20 miles.

Projects and Surveys.

TAMPA SUBURBAN.—W. H. Kendrick, Tampa, Fla., Pres., writes that the surveys will begin at once for this railway from Tampa, Fla., to Tarpon Springs, Fla., ten miles. The object of the road is to develop the suburban traffic, and in Ybor City and Tampa it will be operated as a street railway.

PADUCAH, TENNESSEE & ALABAMA.—A meeting of the stockholders of this company will be held on June 15, 1892, to consider the issuance of first mortgage bonds at the rate of $20,000 per mile to provide for the construction of the proposed extension from Hollow Rock, Tenn., to the Tennessee Midland R. R.

COLUMBUS & PICKINSVILLE.—This company has been chartered in Mississippi to build a railway from Columbus, Miss., to Pickinsville, Ala. This is the Mississipi incorporation of the Columbus, Tuscaloosa & Atlantic R. R. Co. Pres., C. E. Rodenberg, Columbus, Miss.

LOCKHART SHOALS.—The preliminary survey for this railway from Jonesville to Lockhart Shoals, S. C., 16 miles, has been completed and the location is now in progress. It is stated that contracts will be let about the middle of this month. Pres., C. D. Farrar, Union, S. C.

LEXINGTON & WESTERN.—The incorporators of this company will hold a meeting shortly to complete its organization. It was chartered at the last session of the Virginia Legislature to build a railway from Lexington, Va. to Bristol, Tenn.

BRUNSWICK, ST. MARY'S & FLORIDA.—An exchange says that it is expected that the outcome of the recent meeting of the stockholders of this company will be the early commencement of work. The company was chartered in August, 1891, to build a railway from Brunswick to St. Mary's, Ga.

FRENCH CREEK & LITTLE KANAWHA.—It is stated that negotiations are pending looking toward the early construction of this West Virginia railway. G. A. Newlon, Buckhannon, W. Va., is interested.

CONCORD SOUTHERN.—It is stated that the arrangements are completed for building this road and that the company desires to contract with a civil engineer to make the preliminary surveys for its line. Secy., W. M. Smith, Concard, N. C.

MARION & RYE VALLEY.—The contract for building the first 7-mile section of this railway has been let to W. C. Foster & Co.

NORFOLK, WILMINGTON & CHARLESTON.—A meeting of the Virginia incorporators of this company was held recently to elect officers and directors. It is stated that similar meetings of the North Carolina and South Carolina incorporations will be held soon and then the three sections of the road will be consolidated. The road is to run from Norfolk, Va., to Charleston, S. C., and the preliminary surveys have been completed. It is stated that construction will be commenced within 90 days and about 100 miles of the road completed this year.

Northwest.—Existing Roads.

DULUTH & IRON RANGE.—The contract for building the Western Mesaba Branch, from the main line near Mesaba Station to mining properties about 15½ miles west, has been let to Winston Bros., of Minneapolis, Minn., for $134,000. The work will be quite heavy; maximum grade 1 per cent. and maximum curve 5°. It is expected to begin tracklaying about July 15, and to have the line completed and open for traffic by Aug. 15.

KANSAS CITY, WATKINS & GULF.—This railway from Lake Charles to Alexandria, La., 97 miles, was completed and opened for traffic on April 28.

CHICAGO, FT. MADISON & DES MOINES.—The right of way has all been secured for the proposed extension from Libertyville to Ottumwa, Ia., 25 miles. It is probable that work will begin soon.

CHICAGO & NORTHWESTERN.—This company will expend about $2,000,000 this year in preparing for the World's Fair traffic. The new work will consist largely in improving the terminals at Chicago, in double tracking and in putting block signals.

Projects and Surveys.

LITTLE WABASH.—The stockholders voted on April 28 to issue $1,500,000 of first mortgage bonds for constructing and equipping this line from Effingham to Carmi, Ill. via Sailor Springs. The right of way, it is reported, has nearly all been secured.

MINNESOTA & WISCONSIN.—Chartered in Wisconsin to build a railway from a connection with the Chippewa branch of the Chicago, Milwaukee & St. Paul Ry. to St. Paul, Minn., about 100 miles. Among the incorporators are: R. B. Langdon, H. C. Truesdale and D. M. Sabin, of Minneapolis, Minn., and D. C. McKay and Wm. Gilbert, of Wildwood, Wis.

YANKTON, NORFOLK & SOUTHWESTERN.—A force of about 100 men is at work on the line of this proposed railway from Yankton, S. Dak., to Norfolk, Neb. It is stated that the bonds of the company have been sold and that the line will be completed this season.

ILLINOIS & IOWA RY. & TERMINAL CO.—Ch. Engr. Geo. T. Baker has recently been over the proposed line of this company's railway between Davenport and Clinton, Ia., and reports the people very favorably disposed toward the road. It is thought that the right of way can be secured without any difficulty.

Southwest.—Existing Roads.

KANSAS CITY, NEVADA & FT. SMITH.—At a recent meeting of the stockholders of this company it was voted to increase the capital stock of this company $1,200,000 to provide for the proposed extension to Ft. Smith, Ark. It is proposed to have 50 miles south from Hume, Mo., completed this year.

Rocky Mt. & Pacific.—Existing Roads.

SNOHOMISH, SKYHOMISH & SPOKANE.—It is expected that this railway will be completed between Everett and Port Gardiner, Wash., in about two weeks.

KANSAS CITY, EL PASO & MEXICAN.—Press dispatches state that this 10-mile railway from El Paso to Lanoria, Tex., has been purchased by the Gould interests and that work has already begun on its extension to White Oaks, New Mex., 150 miles.

ASTORIA & PORTLAND.—About 600 men are now at work on this railway from Astoria to Portland, Ore. Geo. Goss, Astoria, Ore., Ch. Engr.

Projects and Surveys.

YAKIMA, NATCHEZ & EASTERN.—This company has been organized in Washington to build a system of narrow gage railways in the vicinity of North Yakima. Among the incorporators are Geo. Donald, Edward Witsen and G. M. McKinney.

Foreign.

MEXICO.—The concession held by Gen. Trevino and Emeterio de la Garza, for the construction of railways in North Mexico, has been regranted with modifications. The lines to which the concession refers are the following: From the station of Trevino on the Monterey & Mexican Gulf Ry. to Sierra Mojada and to a point of connection with the Mexican Central Ry., in the State of Chihuahua, and with the Topolobampo Ry., when the latter is built, with the right to build on to a point on the Pacific coast. From a point between the stations of Cadereyta and Monte Morelos, on the Monterey & Mexican Gulf Ry. to a point on the Rio Bravo between Laredo and Guerrero. From a point between the stations of Linares and Villagran, on the Monterey & Mexican Gulf Ry., to the mining camps of San Carlos and San Nicolas, with the right to prolong the line to the Laguna Madre and Soto La Marina. The time allowed for the completion of these lines is ten years. Up to Dec. 31, 1893, the company may build as large a portion of the above railways as it sees fit, on the understanding that the subvention bonds issued with respect to the sections built previously to that date shall not begin to bear interest until Jan. 1, 1894. Subsequently to the above-named date, the company is to construct in each fiscal year the number of kilometers that the Department of Communications may previously determine on. The subsidy is $80,000 per kilometer payable annually in 6 per cent. bonds, which the company receives at 90 per cent. of their par value and which the Government agrees not to redeem within ten years from the date of their issue.

NICARAGUA.—It is announced that the Nicaraguan Government has granted a concession to build a railway from the city of Massaya to Catrine, Maratepe, San Marcos, Jinetepe and Diriembe, to Wm. Climmie of the United States.

ELECTRIC RAILWAYS.

SANFORD, ME.—A line to Kennebunkport, 18 miles, is projected for freight and passenger service. Surveys are said to have been made and the cost is estimated at $100,000.

GLOVERSVILLE, N. Y.—The Johnstown, Gloversville & Kinsboro Ry. Co. has awarded a contract for electrical equipment to the Thomson-Houston Co., including trolley wires, two 85-HP. generators and four vestibule cars 18 ft. long with two 15-HP. motors to each car. The line will be about four miles long, will cost $60,000, and is to be in operation by July.

PITTSBURG, PA.—Liberty Ave. Street Ry. Co., $50,000; Pres., Charles Hook.

NEW ORLEANS, LA.—The New Orleans & Carrollton Ry. is to be converted to an electric line, being the first railway in that city to make the change. The line is 20 miles long, and will have 50 motor cars, a steam power plant of 1,000 HP., and the entire track will be relaid with 72-lb. rail with Johnston safety disconnections. Mr. A. Langstaff Johnston is Chief Engineer. The Thomson-Houston Co. has the contract for electrical equipment, and the track will be built by J. G. White, of New York.

CHICAGO, ILL.—A line on 22nd. St. is projected by a company backed by C. L. Bonney, C. C. Noonan and others. It will be six miles long, and the trolley system will be used.

HAMMOND, ILL.—The Hammond Street Ry. Co. has been organized, and the Short electric system will be employed. The incorporators are O. W. Brooks, F. W. Short and J. H. Burt.

ELGIN, ILL.—The Elgin, Aurora & Fox River Electric Ry. Co. has been incorporated by Mayor Grote, of Elgin; Senator Evans, of Aurora; Mr. J. M. Egan, President of the Chicago, St. Paul & Kansas City Ry., and Mr. Gardner, of the First National Bank of Chicago. Capital stock, $400,000.

HORSE RAILWAYS.

BROCKTON, MASS.—The Brockton & Holbrook Street Ry. Co. has been granted a franchise, and will commence work very soon.

NEW YORK, N. Y.—The following companies to build lines in Weschester Co. have been incorporated by Howard Carroll, Geo. C. Clausen, Thurlow Weed Barnes, F. M. Pearson and C. E. Coddington, of New York: Suburban Traction Co., 5 miles, $150,000; West Farms & Weschester Traction Co., 3 miles, $80,000; Williamsbridge & Westchester Traction Co., 4 miles, $80,000; Van Nest, West Farms & Westchester Traction Co., 5 miles, $150,000; Wakefield & Westchester Traction Co., 7 miles, $125,000.

HAMILTON, ONT.—The Hamilton Street Ry. Co. will build about 8 miles of new track.

HIGHWAYS.

NEW YORK.—A wagon road is to be built from Lake Placid to the summit of Whiteface Mountain. Mr. Charles E. Martin, Manager of the Mirror Lake Hotel, Lake Placid, N. Y., is at the head of the project.

PENNSYLVANIA.—Chalfont & Doylestown Turnpike Co., $15,000; John M. Purdy, Doylestown; Preston W. Haggerty, Califont.

OHIO.—Proposals will be received by Henry J. Caren, Auditor of Franklin Co., Columbus, O., until May 31 for 23,500 cu. yds. of fill, 1,600 cu. yds., of gravel, 382 perches of rip rap relaid, 755 cu. yds. of broken stone, steam rolled; 375 cu. yds. of broken stone screenings, 4 sewer drops, 200 rods of 4-in. tile and 1,492 sq. yds. of sidewalk.

KENTUCKY.—Proposals will be received until May 11 by W. E. Jones, Mount Sterling, Ky., for the construction of two miles of the Ewington & Stepstone turnpike road, according to plans and specifications now on file with W. A. DeHaven, Mount Sterling.

BRIDGES, TUNNELS AND CANALS.

FRANKLIN, CO., O.—Bids will be received until May 31 for the construction of a bridge over Big Walnut Creek, Truro township, Franklin Co. The bridge is to be 150 ft. long, with a 20-ft. roadway. Henry J. Caren, Co. Aud.

WATER-WORKS.

New England.

ROCKLAND, ME.—Engr., P. M. Blake, Hyde Park, Mass., is making a survey for a connection between Hobbs and Fish lakes and Mirror Lake, to reinforce the supply from the latter. The distance between the lakes is said to be about two miles.

GOFFSTOWN, N. H.—The works are to be extended to Parker's Village.

MEREDITH, N. H.—A. S. Clough informs us that an attempt to secure works is being made.

PENACOOK, N. H.—May 5 an election will be held in the water precinct to vote on abandoning the contract with the Boscawen & Penacook Water-Works Co., on purchasing the charter rights and franchises of the company, and on constructing precinct works.

BOSTON, MASS.—Bids will be received by the Boston Water Board until May 9 for laying a 6-in. main to Thompson's Island. Wm. Jackson, Cy. Engr.

LAWRENCE, MASS.—May 6 the Water Board will hold a special meeting to consider filtration.

QUINCY, MASS.—The people voted April 30, 1,138 to 474, to buy the works of the Quincy Water Co.

SWAMPSCOTT, MASS.—Bids will be received by the town until May 11 for laying cast iron pipe. Chn., A. R. Bunting.

BETHEL, CONN.—A report on an additional supply will be made by Engr. J. K. Wilkes, Danbury.

SOUTH NORWALK, CONN.—The people have voted against the proposed extension to Bell Island and Roton Point, noted last week. It is reported that the Roton Point Improvement Co. will buy the spring from which the Point is now supplied and improve the present service.

WESTPORT, CONN.—It is reported that Marsh, Lemon & Co., Bridgeport, have offered to buy the franchise now held by the Westport Water Co., from a Boston syndicate, provided the town will grant them a lighting franchise. No further legislation is needed. A well, pumping station and distributing reservoir are proposed.

Middle.

DUNKIRK, N. Y.—The Governor has signed a bill authorizing the Council to issue $60,000 of bonds for improvements.

FAYETTEVILLE, N. Y.—A gravity supply from Palmer Spring is proposed. Wm. Austin and E. F. Hopkins are on the Water Committee.

LIBERTY, N. Y.—Bids are wanted for $20,000 of bonds for works.

WALDEN, N. Y.—Works are projected.

WALTON, N. Y.—It is reported that the mains will be extended two miles.

ATLANTIC CITY, N. J.—Pitney Pond, at Port Republic, has been bought by the Consumers' Water Co.

MANASQUAN, N. J.—The township of Wall has granted the New Jersey Shore Water Co. permission to lay mains to this place. J. T. Ontonides, Township Clerk.

AMBLER, PA.—A company has been formed and proposes to bring in water from springs near by.

CANNONSBURG, PA.—Works are projected.

CARROLTON, PA.—It is reported that works will be built.

ETNA, PA.—The borough is trying to arrange with the Spang-Chalfant Co. for joint works for the borough and the company's mill.

MARIETTA, PA.—Surveys are being made for projected private gravity works, with a reservoir.

NEW MILFORD, PA.—The New Milford Water Co. was incorporated April 28; Treas., E. S. Garrett; capital stock, $15,000.

NICHOLSON, PA.—W. F. Halstead, Geo. B. Jermyn and others have petitioned for the incorporation of the Citizens' Water Co. to supply this place.

PHILADELPHIA, PA.—A $1,000,000 loan for the building of the Schuetzen Park reservoir and the improvement of the water supply is under consideration.

CAMBRIDGE, MD.—May 10 the people will vote on $50,000 for works.

CATONSVILLE, MD.—There is talk of extending the company's mains to supply Glenartney, Avalon, St. Dennis, Hallethorpe and other suburbs of Baltimore. A main is being laid to bring in a new supply from three streams about three miles distant.

ELLICOTT CITY, MD.—Thomas T. Horney, Scranton, and Joseph Schreiber are each thinking of putting in works. Mr. Schreiber put in electric lights.

Southern.

DANVILLE, VA.—A water power pumping plant is proposed.

ROCK HILL, S. C.—It is reported that a franchise has been granted, and that the supply will be from the Catawba River.

WYETH CITY, ALA.—The directors of the Wyeth City Land & Improvement Co. have voted to contract for the building of works, including a reservoir.

MILAN, TENN.—Works are talked of with a supply from an artesian well.

LUDLOW, KY.—A public meeting has been held to discuss a supply from the Covington works. The Council was requested to call a special election to vote on issuing $25,000 of bonds. G. T. Latta, R. H. Flemming and others were appointed as a water committee.

North Central.

BRYAN, O.—A second vote on the building of works will be had May 9. The town has authority to issue bonds.

GREENVILLE, O.—A proposition to build works has been made by Syracuse, N. Y., parties, probably Moffett, Hodgkins & Clarke.

WEST MILTON, O.—Surveys for works have been made.

WYOMING, O.—The Village Council has voted to issue $35,000 of bonds and build works. Mayor, R. D. Barney; Clerk, W. A. Clark.

CHICAGO, ILL.—The sum of $1,000,000 has been voted by the Council for water pipe extensions. Much pipe has been distributed for some time, awaiting money for laying.

HARVEY, ILL.—J. P. Miller & Co., Chicago, have been awarded a contract for sinking a 4-in. well for increasing the water supply.

Northwestern.

CHARTER OAK, IA.—Bonds to the amount of $3,500 will be issued for works.

IOWA FALLS, IA.—The people have voted for works.

FAIRMOUNT, MINN.—Plans for works are being made and it is expected that contracts will soon be let.

LEXINGTON, NEB.—Bonds for works have been voted.

CHAMBERLAIN, S. DAK.—A press dispatch from this place states that works are being built for the Crow Creek Indian Agency.

Southwestern.

FORREST CITY, ARK.—It is reported that this place will soon have works.

DUBLIN, TEX.—It is expected that the construction of works will soon be started. A large reservoir is proposed.

EL PASO, TEXAS.—M. P. Hillyer talks of buying the company's works and introducing a new supply from the Sacramento Mts., in connection with an irrigation scheme.

HENRIETTA, TEX.—At a recent mass meeting the people were in favor of building works.

OAK CLIFF, TEXAS.—Improvements to the company's works are proposed, after which the town, it is said, will have an opportunity to buy the works or pay a yearly hydrant rental of $5,000.

ROCKPORT, TEX.—The Rockport Water-Works Co. has been incorporated by J. D. and D. R. Scrivner and John Lackey; capital stock, $20,000.

GALLUP, N. MEX.—Engr. Sam. M. Rowe, Chicago, has submitted plans for works, estimated to cost about $12,000. About 1½ miles of 6, 4 and 3-in. cast iron pipe and 10 hydrants are proposed.

Pacific.

HEPPNER, ORE.—The sum of $15,000 is available for works.

LA GRANDE, ORE.—Bids are wanted by the city until May 18 for about 1,600 ft. of 4-in., 17,185 ft. of 6-in., and 13,649 ft. of 10-in. pipe; valves, boxes, 41 hydrants, 7,100 lbs. of specials, laying and setting the above; a supply well, 1,000,000-gallon pumping plant, and a reservoir. J. H. Slater, J. M. Berry, J. M. Church, Commission on Works. Engrs., Adams & Gemmell, Pendleton, Ore. The city has sold $30,000 of 6 per cent. water bonds.

LOGAN, UTAH.—Propositions to build private works are before the Council. City works furnish the present supply.

Canada.

MONTREAL, P. Q.—It is reported that the Montreal Water & Power Co. is making plans for the works designed to supply the adjoining municipalities, from which it has secured franchises. A water power privilege will be utilized. The franchises call for a water supply by next December.

ALLISTON, ONT.—Bids for works were to be opened April 30. Jas. Jarrett, Chn. Fire and Police Com.

NORTH BAY, ONT.—Bids for building works will be received until May 17. Consult. Engr., John Galt, Toronto; also for $37,000 of 5 per cent. 30-year bonds, until May 10. Treas. and Clk., John G. Cormack.

BRANDON, MAN.—Bids are wanted until May 10 for trenching and pipe laying for water and sewerage systems. Cy. Clk., J. C. Kerr; Consult. Engr., Thos. Worswick, Toronto.

ARTESIAN WELLS.

MIDDLETOWN, N.Y.—The expenditure of $10,000 for artesian wells for the water-works is proposed.

DE SMET, S. DAK.—The city has contracted with Miles & Co., for a well 1,500 ft. deep, 6-in. hole, work to be started by June 1.

IRRIGATION.

KERN COUNTY, CAL.—The Poso Irrigation District has let a contract for the construction of its system to the Portland Construction Co., for $450,000 in bonds.

SAN BERNARDINO, CAL.—The Arrowhead Reservoir Co. has contracted with Creighton & Duer, San Francisco, for the construction of three tunnels, 5,700 ft., 2,070 ft., and 3,300 ft. long. A large dam will soon be built.

SAN JACINTO, CAL.—The San Jacinto & Pleasant Valley Irrigation District has voted $350,000 of bonds for irrigation works.

NEW COMPANIES.—Toltec Land, Reservoir & Irrigation Co., Antonito, Colo.; Wm. S. McMillan, St. Louis, Mo.; Hugh McMillan, Antonito, Colo.; Henry H. Rogers, New York, and others; $500,000. Conejos & San Antonio Reservoir & Ditch Co., Denver, Colo.; $110,000. Oregon Land, Irrigation, Lumber & Fuel Co., Portland, Ore., $500,000.

SEWERS.

WESTFIELD, MASS.—The plans for sewerage on the north side of the river have been accepted by the State Board of Health. Bids are asked until May 12 for 25,000 ft. of sewer pipe, also for laying the same. See advertisements.

CHICOPEE, MASS.—Orders have been passed for 460 ft. of 12-in. and 550 ft. of 18-in. pipe sewer, and 350 ft. of brick sewer.

HARTFORD, CONN.—Two plans have been presented for the Sargeant St. sewer; one costing $18,000, the other $32,000.

NEW HAVEN, CONN.—The contract for the Mott St. sewer has been awarded to Brazos & Sons at $28,623.

MERIDEN, CONN.—Bids are asked until May 16 for about four miles of outlet sewers, 18 to 30 ins. diameter, together with an inverted siphon about 2,100 ft. long, and construction of disposal grounds. W. S. Clark, Cy. Engr.

FLATBUSH, N. Y.—Bids are asked until May 11 for all the sewers in sub-district 2 of District No. 1. Henry Hesterberg, Pres. St. Comrs.

CORTLAND, N. Y.—At a public meeting April 29 an address was made by Prof. C. C. Brown, of Union College, Consulting Engineer to the State Board of Health, and a resolution was unanimously adopted directing the trustees to proceed with the necessary plans for a complete sewerage system.

GLENS FALLS, N. Y.—The citizens will vote May 12 upon the adoption of the plans prepared by S. E. Babcock, Engr., and the issue of sewer bonds for $167,665.

NEW YORK, N. Y.—Bids are asked until May 12 for two sewers, including all branches. L. J. Heintz, St. Comr., Wards 23 and 24.

ALBANY, N. Y.—Bids are asked until May 16 for 12-in. vitrified pipe sewers in two streets. T. J. Lanahan, Clk., Bd. of Contract.

NIAGARA FALLS, N.Y.—Contracts have been awarded to R. D. Young, of Niagara Falls, at $16,774, and Wm. Franklin, of Buffalo, at $22,809.

OLEAN, N. Y.—The Council has reported plans for a system of outlet sewers, to cost $55,000. A special election will be held May 7 to vote on the proposition.

FREEHOLD, N. J.—At the annual meeting of citizens April 25, a resolution was adopted requesting the incoming Board of Commissioners to take measures for the construction of a complete system of sewers for the town.

ORANGE, N. J.—In our issue of April 16 we published the itemized bids received for the valley and outlet sections of the Orange sewerage system. We have since received the approximate lengths, which are as follows: Valley section—78-in. brick, 1,675 ft.; 72-in., 425 ft.; 48-in., 2,180 ft.; 36-in., 325 ft.; 33-in., 900 ft.; 24-in. vitrified pipe, 275 ft.; 18-in., 2,700 ft.; 12-in., 1,300 ft.; 10-in., 955 ft.; 9-in., 1,010 ft.; 8-in., 39,845 ft.; 18-in. iron pipe, 1,650 ft.; 10-in., 2,275 ft. Outlet Section—24-in. vitrified pipe, 10,000 ft.; 48-in. brick, 3,400 ft.; 28x46 in., 11,000 ft.

WILKINSBURG, PA.—It is proposed to issue sewer bonds for $160,000.

BALTIMORE, MD.—Bids are asked until May 11 for a sewer in several streets. A. E. Smyth, Cy. Coun.

NASHVILLE, TENN.—Since the dismissal of the petition of the Council, noted last week, the Council has passed resolutions forbidding the employment of convict labor on city contracts, and making a violation of this punishable by a fine of $50 for each day that convicts are worked. The Board of Public Works has voted this act unconstitutional, and refused to enforce it. Mr. Goodwin has, however, been arrested and fined $50.

BROOKLYN, O.—Bids are asked until May 17 for several sewers. C. N. Collins, Clk. Com.

COLUMBUS, O.—The contract for a sewer in Moler road has been awarded to W. G. Loeffler, at $21,577.

SPRINGFIELD, O.—Bids are asked until May 17 for several sewers. T. D. Wallace, Cy. Clk.

IRVINGTON, IND.—The Town Board has voted to build a 24-in. sewer through Ritter's addition.

NEGAUNEE, MICH.—The Mayor is corresponding with pipe companies concerning material for the proposed sewers, the construction of which will begin soon.

SOUTH SPRINGFIELD, ILL.—It has been voted to construct a sewer to cost at least $10,000.

SHEBOYGAN, WIS.—Bids are asked for 6,283 ft. of brick and tile sewers.

DULUTH, MINN.—The Council has voted in favor of sewers in several streets.

EL PASO, TEX.—Bids are asked until May 23 for a sewerage system at New Post, Fort Bliss. Capt. Geo. Ruhlen, Asst. Quartermaster, U. S .A.

HOUSTON, TEX.—Bids are asked until May 9 for sewers in the San Jacinto St. district. J. T. Browne, Mayor.

PORTLAND, ORE.—The Council has passed an ordinance providing for a general sewerage system for Portland Heights.

BRANDON, MAN.—Bids are asked until May 10 for trenching and laying the pipes for the city sewerage system. J. C. Kerr, Cy. Clk.

STREETS.

HAVERHILL, MASS.—Bids are asked until May 9 for 100,000 paving blocks, 6,500 lin. ft. of granite edgestones, 2,000 lin. ft. of granite flagstones, and such brick as may be needed the ensuing year. J. S. Fuller Clk., St. Com.

ITHACA, N. Y.—The city is asking bids for 30,000 sq. yds. of macadam pavement.

GREENBUSH, N. Y.—The trustees have voted to pave Broadway with granite blocks.

NEW YORK, N. Y.—Bids are asked until May 12 for paving 153d St. with trap blocks, and 142d St. with granite blocks. L. J. Heintz, Com. St. Impts., Wards 23 and 24.

TROY, N. Y.—Asphalt pavement will be laid on one street.

NEWARK, N. J.—The Board of Works has authority to spend $500,000 in street improvements.

BALTIMORE, MD.—Bids are asked until May 11 for 700 lin. ft. of 6-in. granite curbing. A. E. Smyrk, Cy. Comr.

WASHINGTON, D. C.—The District Commissioners ask bids until May 9 for 800,000 vitrified brick, also for asphalt paving tiles.

CHARLESTON, S. C.—The Committee on Streets has recommended that an avenue 110 ft. in width be opened along the Ashley River, according to surveys made by L. J. Barbot, Cy. Engr.

FINDLAY, O.—Bids are asked until May 16 for grading several streets and paving the roadway, about 60 ft. in width, with fire clay brick. Jarvis S. Humphrey, Cy. Engr.

MANSFIELD, O.—Bids are asked until May 21 for grading one street. J. Y. Glessner, Cy. Clk.

ANDERSON, IND.—The city will pave several streets with brick.

TERRE HAUTE, IND.—Bids are asked until May 10 for paving one street with brick, and two streets with screened gravel; also until June 7 for paving one street with brick. C. H. Goodwin, Cy. Clk.

GALESBURG, ILL.—Bids are asked until May 15 for cutting and setting about 20,000 lin. ft. of curbing stone. Bick & Glann.

OTTAWA, ILL.—The Council has voted to build 30 miles of brick sidewalks, to cost about $80,000.

MILWAUKEE, WIS.—Bids are asked until May 9 for about 15 contracts, including cedar blocks in 11 streets. G. H. Benzenberg, Cy. Engr.

KANSAS CITY, MO.—The Board of Park Commissioners have recommended that Eleventh St. be converted into a boulevard 100 ft. in width. The estimated expense is $350,000.

ST. LOUIS, MO.—The Board of Public Improvements has voted in favor of 41 improvements.

SALT LAKE CITY, UTAH.—The Council has voted to issue bonds for $600,000 for permanent improvements. New paving and sewer districts have been created, and considerable work authorized.

LOS ANGELES, CAL.—The Council has voted to pave one street with asphalt on concrete.

SAN FRANCISCO, CAL.—The Board of Supervisors has voted to pave six streets with bitumen and five with basalt blocks.

TACOMA, WASH.—The Board of Public Works has voted to improve ten streets by grading and building sidewalks. The estimated cost is $34,430.

ELECTRICAL.

BROOKLYN, N. Y.—Contracts for city lighting, with both electricity and gas, have been renewed at the present prices, which were published in our issue of March 26.

HACKETTSTOWN, N. J.—The Committee on Lights has been instructed to ask bids for electric street lighting. A. C. Protzman, Town Clerk.

PEN ARGYL, PA.—Bids are asked until May 12 for one 20-light arc dynamo with all fixtures. W. P. Messinger, Secy., Electric Light & Power Co.

CUTHBERT, GA.—The city has voted to issue bonds for an electric lighting plant.

NASHVILLE, TENN.—The Thomson-Houston Co. is enlarging its plant. At present it furnishes the city 250 arc lights, and it is intended to increase them to 500. The company desires the city to advertise for a new contract for lights before the October expiration of the present one, so that the size of the plant can be determined accordingly.

CARTHAGE, O.—The citizens have voted in favor of issuing bonds for an electric light plant.

CINCINNATI, O.—Bids have been received for street lighting, and it is claimed that the lowest is that of the Cincinnati Edison Electric Co., $84.50. A petition has been signed by about 10,000 business men, asking that the contract be awarded to this company.

CHICAGO, ILL.—The South Park Commissioners have awarded the contract for erecting an electric light plant at Washington Park to the Brush Electric Co., Cleveland, O., at $63,250. The plant will include a power house, Corliss engine, boilers, lamps, etc.

BURLINGTON, IA.—The following bids have been received for street lighting: Fort Wayne Jenney, 65 arc lights of 2,000 c. p. each, for five years, $130 per light per year, and 250 incandescent lights of 20, 25 and 30 c. p., $18, $21, $24; Brush Electric Co., similar contracts, $105 and $16, $20.50, $23.50; Thomson-Houston, $100 and $16, $20, $23; J. C. Hubinger, Keokuk, 125 to 150 arc lights of 2,000 c. p. each, $85.

SHELDON, IA.—The city will vote, May 16, upon granting a franchise to H. W. Conant, of Sheldon, for an electric lighting plant. The proposed plant will furnish both arc and incandescent lights, cost about $15,000, and the city will not be asked to take any number of lights

KANSAS CITY, KAN.—A proposition has been made by Thomas Wolfe to erect a 1,200 HP. plant to cost about $250,000, and accept the bonds of the city in payment. Mr. Wolfe will then lease the plant.

MONTREAL, QUE.—The Committee on Lights desires bids for lighting the city. The present contract expires in August, and is for $80 per lamp, but the company wants an increase to $90.

NEW COMPANIES.—Phoenix Consolidated Gas & Electric Light Co., Denver, Colo.; $300,000; Frank Evans, C. F. Musgrove, D. A. Abrams. Harris-Woodruff Electrical Co., Birmingham, Ala.; $40,000; W. C. Harris, W. R. Woodruff. Cardarelli Electric Light Crane Co., Sumter, S. C.; $6,000; H. J. Harley, R. M. Wallace, E. Cardarelli.

CONTRACT PRICES.

SEWERS.—Hornellsville, N. Y.—The contract for 93,765 ft. of sewers has been awarded to Miller & McDougal, at $87,874. The itemized bid is as follows:

42-in. brick sewer, 1,000 ft.	per lin. ft.		$3.40
40-in. " " 1,300 ft.	"	"	3.13
33-in. " " 1,000 ft.	"	"	2.25
24-in. pipe storm sewer, 1,000 ft.	"	"	1.65
12-in. basin connections, 250 ft.	"	"	.41
10-in. inlet connections, 200 ft.	"	"	.34
24-in. pipe sewer, 3,975 ft.	"	"	2.25
24-in. Y's, 100			3.00
20-in. pipe sewer, 2,475 ft.	"	"	2.40
20-in. Y's, 80			2.10
18-in. pipe sewer, 1,975 ft.	"	"	3.00
18-in. Y's, 65			1.60
15-in. pipe sewer, 1,575 ft.	"	"	1.40
15-in. Y's, 55			.85
12-in. pipe sewer, 3,375 ft.	"	"	.63
12-in. Y's, 100			.60
10-in. pipe sewer, 7,050 ft.	"	"	.53
10-in. Y's, 290			.50
8-in. pipe sewer, 68,815 ft.	"	"	.33
8-in. Y's, 2,200			.25
6-in. hs. cons., 6 to 8 ft. dp., 5,000 ft	"	"	.19½
6-in. " " 8 to 10 ft. dp., 3,000 ft.	"	"	.22½
Manholes less than 12 ft., 2,000 ft.	"	"	3.00
Manholes more than 12 ft., 500 ft.	"	"	2.50
Basins, 12	each		60.00
Inlets, 12	"		35.00
Flush tanks, 58	"		40.00
Lampholes, 200	"		2.00
Concrete, 500 cu. yds.	per cu. yd.		2.50
Rock excavation, 500 cu. yds.	"	"	.50
Castings, 160,000 lbs.	per lb.		.2¼
Cast iron pipe, 20 tons	per ton		22.50
Spruce foundations, 50,000 ft.			15.00
Spruce sheathing, 100,000 ft.			15.00
Hemlock sheathing, 100,000 ft.			12.00
Excav. below grade, 500 cu. yds.	per cu. yd.		.50
3-in. tile, 2,000 ft.	per lin. ft.		.05
4-in. tile, 4,000 ft.	"	"	.07
6-in. tile, 8,000 ft.	"	"	.10

West Newton, Mass.—The contracts for sections 4 and 5 of the Newton sewer system have been awarded to A. A. Hall, of Boston, at $73,569 and $68,127. The following is the itemized bid for each section: Excavation, to 8 ft., 58 cts. per cu. yd.; 8 to 14 ft., 80 cts.; 14 to 20 ft., 97 cts.; 20 to 26 ft., $1.24; rock excavation, $4.25, $6.50, $7 and $8; brick masonry, $4.60 per cu. yd.; concrete and rubble, $3; pipe laying, 8 cts. per lin. ft.; with jute, 10 cts.; chimney pipe, 8 cts.; subdrain pipe, 12 cts.; spruce lumber, $30; spruce piles, 15 cts. per lin. ft. The contract for cast iron manhole frames and covers was awarded to the Concord Foundry Co., of Concord, N. H., at $6.50 per set.

Newark, N. J.—The following contracts have been awarded: Thos. O'Connor, 12-in. pipe sewer, 55 cts. per lin. ft.; manholes, $28 each; basins, $80; James Dolan, 15-in. pipe, 81 and 93 cts.; 12-in., 71 and 80 cts.; manholes, $35, $37 and $39; basins, $80.

STREET WORK.—Indianapolis, Ind.—The contract for brick paving on South St., 32 ft. in width, has been awarded to J. W. Cooper & Co., at $5.60 per lin. ft.

Boston, Mass.—The contract for doing the filling on the Commonwealth Ave. extension has been awarded to the Boston Contracting Co., at 49½ cts. per cu. yd. if cars are used, or 54½ cts. with team.

Scranton, Pa.—The Barber Asphalt Paving Co. has submitted the following bill for repairing streets paved with asphalt: Repairs with new material, $1.65 per sq. yd.; with old material, $1.50; for keeping and maintaining such streets during 1892, $200 for each 1,000 yds.; for maintaining all asphalt streets as they successively pass out of guarantee, during five years, $95 per year for each 1,000 sq. yds.

Philadelphia, Pa.—The contracts for repairing paved streets have been awarded as follows: W. J. McNichol, ten sections, 25 to 30 cts. per sq. yd.; David McMahon, one section, 31½ cts. The Vulcanite Paving Co. was the only bidder for resurfacing asphalt pavements, $2 per sq. yd., or with renewed foundation, $3.50.

Newark, N. J.—The following paving contracts have been awarded by E. Adam, City Engineer: Thos. O'Connor, square trap blocks, $1.65 per sq. yd.; J. F. Shanley, trap blocks, $1.60, and oblong granite blocks, $2.35; T. J. Regan, granite blocks, $2.09, $2.13, $2.14 and $2.19; Terence McManus, granite blocks, $2.33.

STREET SUPPLIES.—Jackson, Tenn.—The city has contracted with the Tennessee Midland Ry. for 1,000 car loads of gravel at $13 per car load of 40,000 lbs.

Wilmington, Del.—The contract for 13,000 yds. of Belgian and granite blocks has been awarded to the Brandywine Granite Co., at $1.50 per sq. yd. The bids for furnishing and laying brick ranged from $1.06 to $2.09 per sy. yd., or from $14.50 to $18.55 per M.

Montreal, Que.—The Road Committee has awarded contracts as follows: T. M. Morgan, Portland cement, Crescent brand, 58 cts., and McNally & Co., Globe brand, 58 cts.; Mr. Shepherd, square brick, $8.50, and beveled, $10.50; Frothingham & Workman, and Montreal Rolling Mills, 70,000 lbs. spikes, $2.85 per 100 lbs.; Ovide Dufresne & Bros., 1-in. white pine, tongued and grooved, $15; G. A. Greer, 1-in. rough pine, $11.50; G. S. Shearer, spruce planks, $19; J. & B. Grier, tamarack floats, 8⅝ cts. per lin. ft.; Jos. Brusseau, yellow pine, 11x3-ins., $32.70.

DREDGING.—Chatham, Ont.—The contract for dredging the mouth of the River Thames has been awarded to Massey & McKay, at 18 cts. per cu. yd.

WATER-WORKS SUPPLIES.—Lancaster, Pa.—Contracts have been awarded as follows: Eddy Valve Co., fire hydrants, $26.50 per ton; R. D. Wood & Co., 4-in. valves, $7.95; 6in., $11.75; 8-in., $18; 10-in., $26; 12-in., $34.50; cast iron valve boxes, up to 12 ins., $3 each; Millert Foundry & Machine Co., 4-in., pipe, $26.80; 6-in. and larger, $25.54; R. C. McCully, special castings, 2½ cts. per lb.; stop covers, 2 cts.; Reilly Bros. & Raub, pig lead, 5.45 cts. per lb.; Enterprise Brass Foundry, ferrules, 73 cts. per piece.

MISCELLANEOUS.

GAS.—Burlington, Ia.—The following bids have been received: Burlington Gaslight Co., 250 or more lights, 20 c. p. each, $18 per light per year; for public buildings, $1.50 per 1,000 ft.

JAIL.—Albia, Ia.—Bids are asked until May 16 for a county jail. E. A. Canning, Chn. Bd. Co. Comrs.

LUMBER.—Brooklyn, N. Y.—Bids are asked until May 9 for 1,000,000 ft. of lumber for the Brooklyn bridge. C. C. Martin, Ch. Engr. and Supt.

Chicago, Ill.—Bids are asked until May 10 for the white oak and white pine lumber for the lock and dam at Kampsville, Illinois River. Capt. W. L. Marshall, U. S. Engineer office.

DITCH.—Akron, O.—The County Commissioners will receive bids until May 24 for a ditch to drain Copley Swamp. The estimated cost is $31,000.

APPROACHES, WHARF, ETC.—Washington, D. C.—Bids are asked until May 17 for the approaches for the public building at New Bedford, Mass., also until May 18 for the gangway, wharf, and building thereon, at the U. S. Quarantine Station, Black Bear Island, Sapello Sound, Ga. W. J. Edbrooke, Treasury Dept.

PUBLIC BUILDINGS.—The House Committee has favorably reported bills for public buildings as follows: Altoona, Pa., $150,000; McKeesport, Pa., $100,000; Washington, Pa., $80,000; Pottsville, Pa., $50,000; Jamestown, N. Y., $75,000; Hartford, Conn., $75,000; Elizabeth, N. J., $100,000; Henderson, Ky., $60,000; Logansport, Ind., $60,000; Mansfield, O., $75,000; St. Paul, Minn., $1,300,000; Kansas City, Kan., $200,000.

DREDGING.—Albany, N. Y.—Bids are asked until May 10 for dredging about 8,000 cu. yds. at Bath-on-the-Hudson, and 4,000 cu. yds. near the entrance to the Albany basin. Edward Hannan, Supt. Pub. Wks.

DUMPING BOARD.—New York, N. Y.—The Department of Docks ask bids until May 19 for a new dumping board on the West 30th. St. pier; approximate material, creosoted yellow pine, 49,027 ft. B. M., and uncreosoted, 1,031 ft.; spruce, 7,823 ft.; oak spring piles, length 60 ft., 6; wrought iron spikes and rods, 3,533 lbs.; screwbolts and nuts, 1,427 lbs.; wrought iron strips and washers, 1,394 lbs.; cast iron cleats, washers and bolts, 1,201 lbs. Bids are also asked for repairing the pier; new material required, spruce timber, about 100,660 ft., B. M.; pine, 1,100 ft.; spikes, 5,902 lbs.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES—The Schenectady Locomotive Works, Schenectady, N. Y., have an order for 10 ten-wheel locomotives for the Cleveland, Cincinnati, Chicago & St. Louis. The Richmond Locomotive Works, Richmond, Va., and the Brooks Locomotive Works, Dunkirk, N. Y., have orders for 30 and 10 engines, respectively, of the same type and for the same road. The Brooks Locomotive Works have also an order for 50 consolidation engines, weighing 64 tons, and have delivered a heavy freight engine to the Iron Range & Huron. The Cooke Locomotive Works, Paterson, N. J., have orders for one switch engine and three passenger engines for the Delaware, Lackawanna & Western.

CARS.—The Barney & Smith Mfg. Co., Dayton, O., is building 250 Hanrahan refrigerator cars for the Atchison, Topeka, & Santa Fe. The Middletown Car Works, Middletown, Pa., and the Lebanon Car Works, Lebanon, Pa., are building 250 gondola and 150 box cars, respectively, for the Long Island. The Erie Car Co., Erie, Pa., has an order for 200 gondola coal cars for the Mahoning Valley. National Car Mfg. & Electric Co., Chicago, Ill.; $50,000; T. J. Crane, L. G. Christian and D. Bates. The Missouri Car & Foundry Co., St. Louis, Mo., has increased its capital stock from $750,000 to $1,000,000. The United States Rolling Stock Co., New York, has been reorganized as the United States Car Co., with a capital stock of $3,500,000; Pres., D. Cornfoot; Secy., Robert Green, Jr., Elizabeth, N. J.; Treas., T. B. Parker, New Brunswick, N. J.

WATER TUBE BOILERS.—The Campbell & Zell Co., Baltimore, Md., has closed contracts within the past two weeks for about 5,000 HP. of Zell boilers, including 675 HP., for the Central Ry. Co., of Baltimore, 1,850 HP. for the three new cable plant power houses of the Baltimore City Passenger Ry. Co., and 150 HP. for the Michigan Brass & Iron Works, Detroit, Mich. These orders are in addition to the order for 2,500 HP. boilers for the World's Columbian Exposition.

BUILDINGS.—Plans for a new 20-stall roundhouse, turntable, water tank, etc., at Detroit, Mich., are being prepared for the Flint & Pere Marquette Ry. Also for a 40x212 ft. factory at Nashua, Ill., for the Warner Lock Co. Thomas Appleton, Rialto Building, Chicago, is the consulting engineer.

ALUMINUM.—A company is being organized, with a proposed capital stock of $100,000, to manufacture sheet metal cooking utensils, castings, harness ware, etc. Mr. W. P. Rounds, Rookery Building, Chicago, is the promoter. The works will be located near Chicago.

THE LAKE ERIE ENGINEERING WORKS, Buffalo, N. Y., described in Engineering News, Nov. 1, 1890, were put in full operation in October, 1891. Among recent orders are a 600 HP. compound condensing engine for the Buffalo Street Ry. Co., being the third engine of the said capacity to the same parties; two compounds for Louisville, Ky., 200 and 300 HP.; two triple expansion 200 and 300 HP., for the Pueblo (Colo.) Smelting & Reducing Co. They are also building eleven Scotch type marine boilers for the American Steel Barge Co., West Superior, Wis.; two boilers, 14 ft. 9 ins. diameter, 13 ft. long, for the Morgan Iron Works, New York; also two for Bessemer converters for the Homestead Mills, Pittsburg, Pa.; and three 60-ton ice machines for the Buffalo Refrigerating Co. Pres., Richard Hammond; Secy. and Treas., J. Coon; Supt., P. H. Kane; Ch. Engr., E. F. Williams.

THE NATIONAL METER CO., New York, manufacturing water meters, has removed its offices from 252 Broadway to 287 Broadway.

THE PNEUMATIC GATE & MFG. CO., Chicago, has removed its offices to the Monadnock Building. The company manufactures and repairs all kinds of machinery, making a specialty of railway work. Gen. Man., A. J. McDonald.

THE DETROIT ELECTRICAL WORKS have removed their Chicago office to the Monadnock Building. The company manufactures machinery and electrical appliances, hoisting and mining plants, etc. L. E. Myers is the Chicago agent.

THE CHICAGO WATER JACKET CONDENSER CO., Chicago, Ill., has orders from Wiske & Vilter, engine builders, Milwaukee, Wis., for two condensers for two compound Corliss engines of the Mattoon Mfg. Co., Sheboygan. One will be 12 ins. diam., for a 700-HP. engine with cylinders 24x42 and 46x42 ins.; the other will be 14 ins. diam., for an 800-HP. engine with cylinders 24x48 and 46x48 ins. Several condensers have been shipped to California. This condenser was put on the market in December, 1891. Pres., Wm. Baragwanath; Secy., E. Beard.

NEW COMPANIES.—City Plumbing & Construction Co., Chicago, Ill.; $10,000; Wm. Bolgate, A. A. Campbell and Wm. L. Snell. Ogden Clay Mfg. Co., Ogden, Utah; $500,000; to manufacture tile, sewer pipe, etc.; Pres., Solomon C. Stephens; Secy., S. O. Stevens. Manitoba Stone & Asphalt Paving Co., Winnipeg, Mann.; to manufacture paving blocks, sewer pipe, etc.; Mr. Stark is the promoter.

CURRENT PRICE LIST.

RAILS.—New York: $30 at Eastern mills, $30.75 at tidewater; old rails, $20 for iron and $14 to $15 for steel; girder rails $40. Pittsburg: $30; old rails, $21 for iron and $15.50 to $16.50 for steel. Chicago: $31.50 to $32; old rails, $19 to $19.50 for iron and $13.50 to $14 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.65 to 1.7 cts.; spikes, 1.95 to 2 cts.; track bolts, 2.6 to 2.65 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.75 to 1.8 cts. for iron and 1.8 to 1.9 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.72 cts. for iron and steel; spikes, 2.1 to 2.15 cts.; track bolts, 2.55 cts. with square and 2.65 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57 1-2 and 47 1-2 per cent. on black and galvanized butt-welded; 67 1-2 and 55 per cent. on black and galvanized lap-welded. Casing 55 per cent.

FOUNDRY PIG IRON.—New York: $14 to $16. Pittsburg: $14 to $15. Chicago: $13.50 to $15.

LEAD.—New York: 4.27 to 4.3 cts. Chicago: 4.1 to 4.15 cts. St. Louis: 4.1 to 4.15 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.3 to 2.8 cts.; channels, 2.25 to 2.5 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.85 to 1.95 cts. for tank, 2.05 to 2.25 cts. for shell, 2.35 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2 to 2.1 cts.; channels, 2 to 2.1 cts.; angles 1.85 to 1.9 cts.; tees, 2.5 cts.; universal iron mill plates 1.85 to 1.95 cts.; sheared steel bridge plates, 1.95 to 2 cts.; refined iron and steel bars, 1.75 cts.; steel plates, 1.9 cts. for tank, 2.1 cts. for shell, 2.2 to 2.3 cts. for flange, 3.5 to 4 cts. for firebox. Chicago: beams, 2.1 to 2.15 cts. for standard, 2.57 cts. for small, and 2.7 cts. for 20-in.; channels, 2.1 to 2.15 cts.; angles, 1.85 to 1.9 cts.; tees, 2.25 cts.; universal plates, 2 cts.; sheared steel plates, 1.95 cts.; steel plates, 2.3 to 2.4 cts. for tank, 2.6 to 2.75 cts. for shell, 2.9 to 3 cts. for flange.